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POWER PLANT IN RAND-McNALLY BUILDING

An Isolated Plant With Unique Means for Handling Coal and Suction Ash Conveyor. Compactness to the Limit, yet Convenience a Maximum

FROM THE TIME YOU and I learned there was such a thing as a map and through the untiring efforts of our teachers were taught to say "Maine, Augusta, on the right bank of the Kennebec River" we have known Rand, McNally & Co., as the maker of those school room puzzles and have wondered how they did it. We find now that it takes power to draw pictures of this earth's face in our books, and no small amount either. Four big boilers and 3 engines, to say nothing of numerous pumps, air compressors, generators, etc., are daily used to interest our boys and girls in the rivers, mountains and cities of our earth.

Yes, I was interested in the maps when I visited the new building of the company at Clark and Harrison Streets in Chicago, but where there is a power plant everything is eclipsed.

As one enters the engine room attention is drawn first to the switchboard. This is the one feature of a power plant where the designer can exhibit his artistic taste combined with convenience in operating a plant, and in this plant the combination has been made with excellent results.

All told there are 15 panels in the switchboard, the body of the board being made of polished slate placed well away from the wall, and the space behind the board enclosed with iron netting. Busbars are of bare copper strips supported on brackets. Three panels are used for controlling the output of the 3 generators, each of these having 2 circuit breakers, 1 ammeter, 1 indicating light, a rheostat handwheel, a voltmeter plug switch and 3 single-throw, single-pole switches.

Two panels contain the necessary switches for the compensators, a clock and a Bristol recording volt-

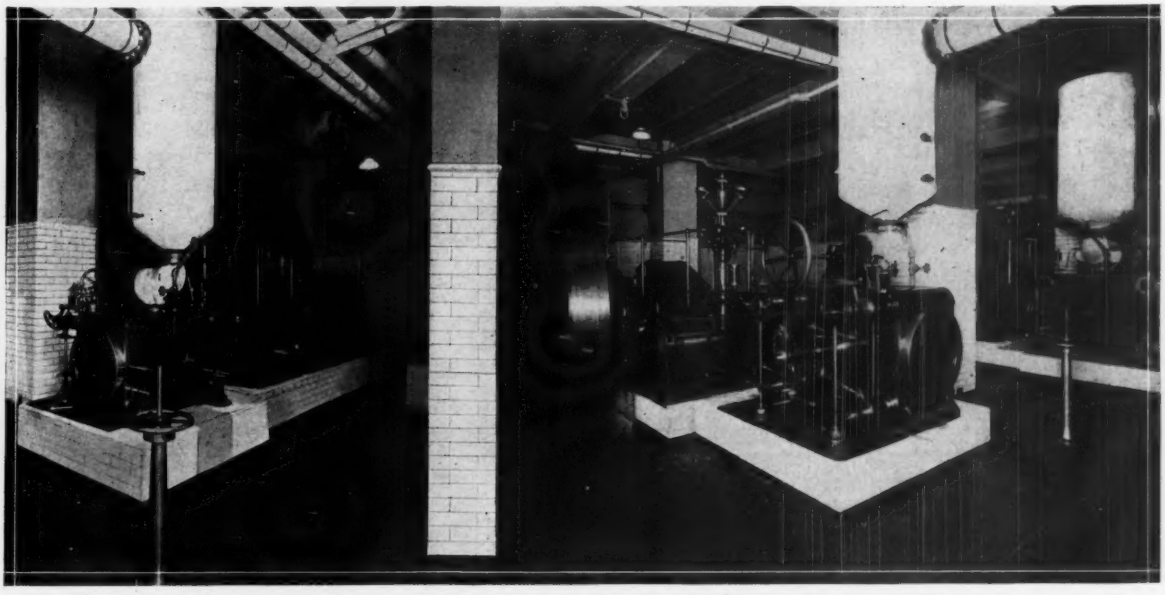

FIG. 1. PANORAMIC VIEW OF THE RAND McNALLY ENGINE ROOM

meter. A totalizing panel supports 12 Sangamo watt-hour meters contained in glass cases. Besides these there are 3 lighting panels and 6 panels equipped with necessary circuit breakers and switches for controlling the power load. At the end of the switchboard nearest the generator panels are swung 2 voltmeters. At the top of each service panel is placed a lin-o-lite lamp with the ground glass cover which gives a pleasing effect without glare. The switchboard is the product of the Sprague Electric Works.

Electric energy is delivered to the switchboard on the 3-wire system and by means of the compensa-

all noncondensing, taking steam at 175 lb. pressure and exhausting to atmosphere or vacuum heating system which causes a back pressure of ½ lb. These engines, as will be noted from the illustration, are of the releasing Corliss type, the valve gear being of a peculiar design. One main eccentric operates the wristplate to which the exhaust valves are attached directly. The admission valves are also operated by this wristplate but cutoff is accomplished by means of cams operated by another eccentric on the shaft, the position of the cams being controlled by the governor.

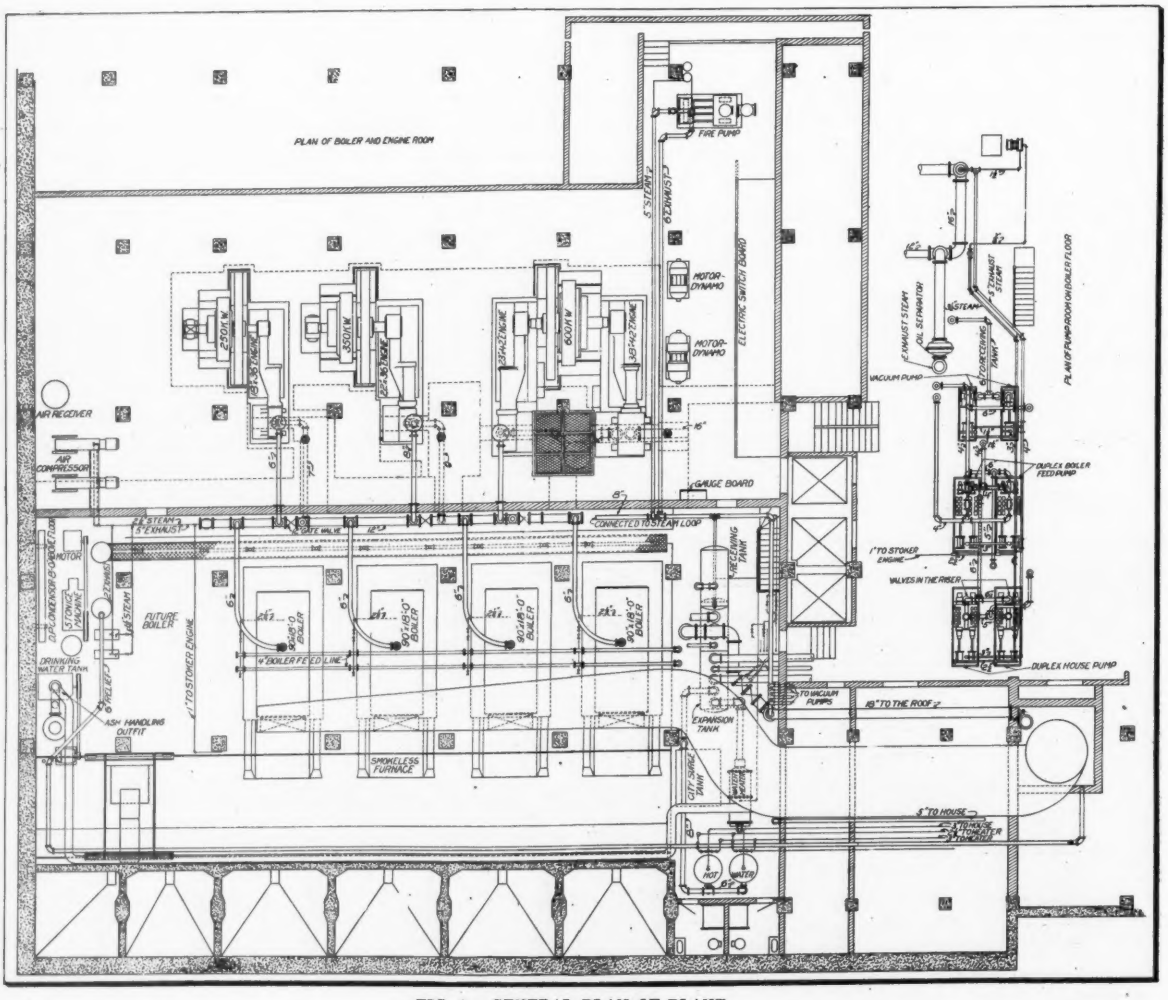

FIG. 2. GENERAL PLAN OF PLANT

ting sets is made available for use on motors at 230 volts and for lights at 115 volts. Two compensator sets are placed directly in front of the switchboard, one of 300 the other 150 amperes capacity.

Generating Units

FOLLOWING back to the source of the electricity we find 3 Crocker-Wheeler generators of 250, 350 and 600 kw. capacity developing direct current at 230 volts. They are mounted upon the engine shafts and have all the latest approved features of design.

Heavy duty Corliss engines, used to run the generators, are 2 simple, 18 by 36 and 22 by 36-in., and 1 cross-compound, 23 and 38 by 42-in., Nordberg engines

Lubrication of the bearings of all engines in the engine room is accomplished by means of a Nugent central oiling system, the oil being forced to the bearings by a head of several feet. After being used, the oil is passed through a Clark-Kreul oil filter before being pumped back to the reservoir which has a capacity of about 3 bbl. For cleaning oil used in hand oilers, an S. F. Bowser Co. filter is employed which is located in the engine room. Lubrication of the cylinders is accomplished with Hills-McCanna oil pumps mounted upon the engine cylinders.

Steam is led to the engines through long-radius bends from the header in the boiler room as will be seen in the illustrations, the use of dry steam being

insured by an angle type receiver steam separator made by the Power Plant Specialty Co.

Two air compressors deliver air at 26 lb. pressure to a receiver through an oil separator all located in the north end of the engine room. These compressors are of the simplex double-acting steam-driven type, 10 by 12 by 10 in., made by the Platt Iron Works Co., constant pressure being maintained by a Gardner governor.

Beside the gage board is placed the recording board for the Venturi water meter which is used to measure the amount of boiler feed water.

Steam Generators

PERHAPS the most interesting and unique features of the plant are found in the boiler room. Here are 4 Lyons combination water and fire tube boilers each rated at a capacity of 350 hp., 90 in. in diameter

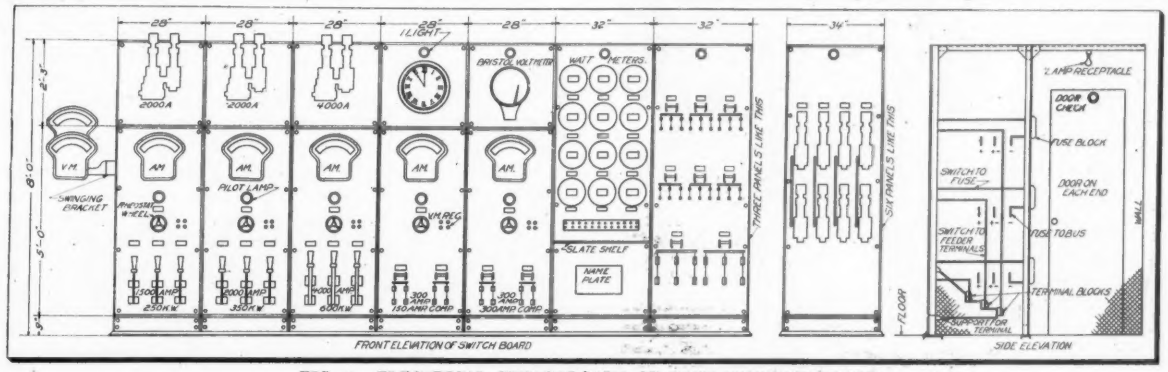

FIG. 3. ELECTRICAL SWITCHBOARD OF RAND McNALLY PLANT

One of the most important pieces of apparatus in the plant, owing to the fire hazard where paper clippings are in abundance, is the Underwriters fire pump. This is of the duplex type made by Henry R. Worthington, 20 by 12 by 16 in. with a capacity of 1500 gal. per minute at 120 strokes. A pressure of 175 lb. is maintained in the sprinkler system which protects the entire building with some 10,000 sprinklers in all. Warning of fire is given the engineer by a Faraday fire signal in the engine room.

by 18 ft. long, containing 188 3½-in. fire tubes and 20 4-in. water tubes, and working at a pressure of 175 lb. A distinctive feature of these boilers, as will be noted by the drawing of the details, is that hot gases do not come in contact with the boiler shell.

The boilers are equipped with Murphy automatic stokers which are operated by 2 engines built particularly for the service. The Dutch oven effect is secured with the Murphy furnace which, combined with the

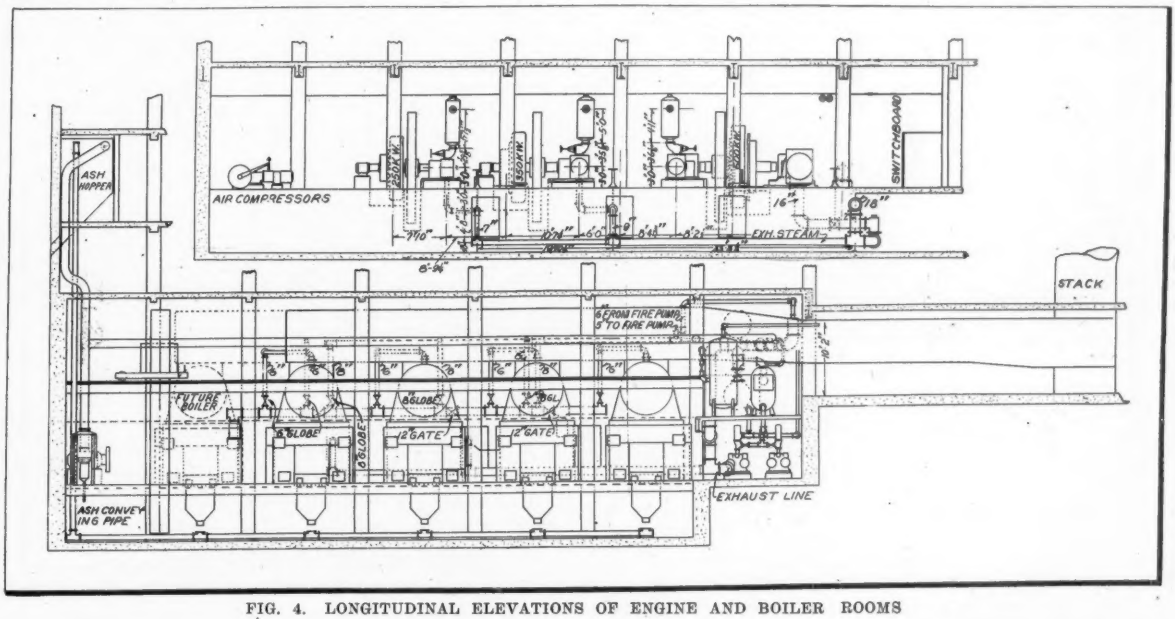

FIG. 4. LONGITUDINAL ELEVATIONS OF ENGINE AND BOILER ROOMS

Located in the engine room as shown in the general plan is the gage board, equipped to show pressure in boilers, expansion tank, city water pipe, steam header, house water tank, air tank and vacuum pump header, also a recording gage for boiler pressure and an Ellison differential draft gage. All pressure gages are the product of Jas. P. Marsh & Co.

feature of feeding coal on both sides, makes smokeless combustion a surety, a necessity for power plants in Chicago.

Boiler equipment consists of Reliance safety water columns, Marsh gages, Monarch flue blowers, Consolidated pop safety valves, Homestead blowoff cocks and Lunkenheimer feed-water and steam fittings.

Coal and Ash Handling

HANDLING the coal is one of the big items of a plant the size of this and the means adopted here are most efficient although novel. Coal is dumped from wagons into 6 bunkers placed under the sidewalk on La Salle Street, each having a capacity of 90 tons. The bottoms of these bunkers are inclined toward a trench in which a plunger is operated by a 1-hp. motor to feed as desired to the hopper of a bucket elevator driven by a 2-hp. motor and handling 15 tons an hour. Coal is then lifted to a 6-ton hopper carried on scales from which it is dumped into the stoker hopper.

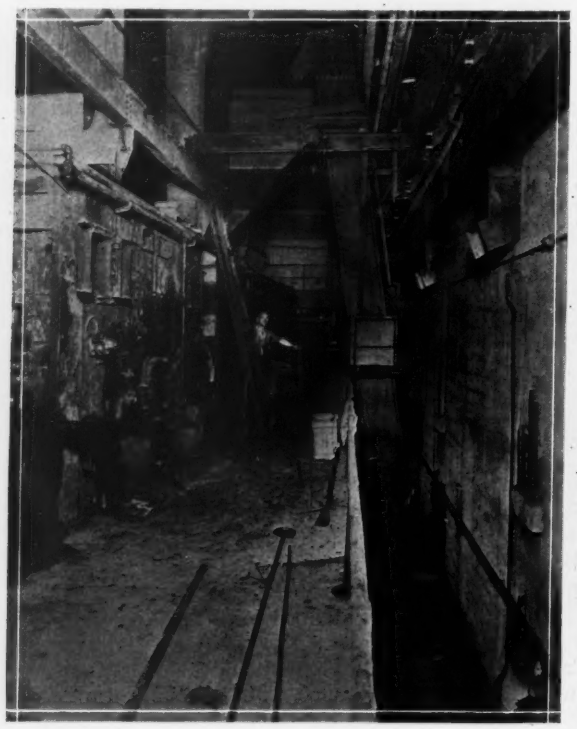

FIG. 6. BOILER ROOM SHOWING COAL ELEVATOR

The entire elevating apparatus including the scales for weighing the coal is carried on rails and by means of a 2½-hp. motor can be traversed the full length of the boiler room. The elevating apparatus is operated by one man from the platform, a switch at each discharge opening from the storage bunkers enabling him to start the motor which runs the shaft in the trench; then by throwing a lever, a clutch engages a chain sprocket and starts the plunger which feeds coal to the elevator.

When the upper hopper has been filled, the operator places a card in the weight recording machine, operates a lever and the net weight of the coal is registered. The coal is then taken to the desired stoker and by means of a lever the operator opens the valve which allows the coal to discharge. When the stoker hopper has been filled and the coal valve closed, the net weight of the coal remaining is recorded on the card, thus accounting for all coal fed to each boiler.

Coal is thus handled entirely without the use of a shovel and the flexibility of the system which permits of taking coal from any part of the storage and delivering it to any stoker, is of particular advantage in a plant of this class. The elevator is the product of Orton & Steinbrenner Co., Standard scales supplied with a Reed recording beam being used.

Another noteworthy feature of this plant is the method of handling the ashes which is by a vacuum system. As will be noted in Figs. 4 and 5, a vacuum pipe line, with proper openings under each furnace to

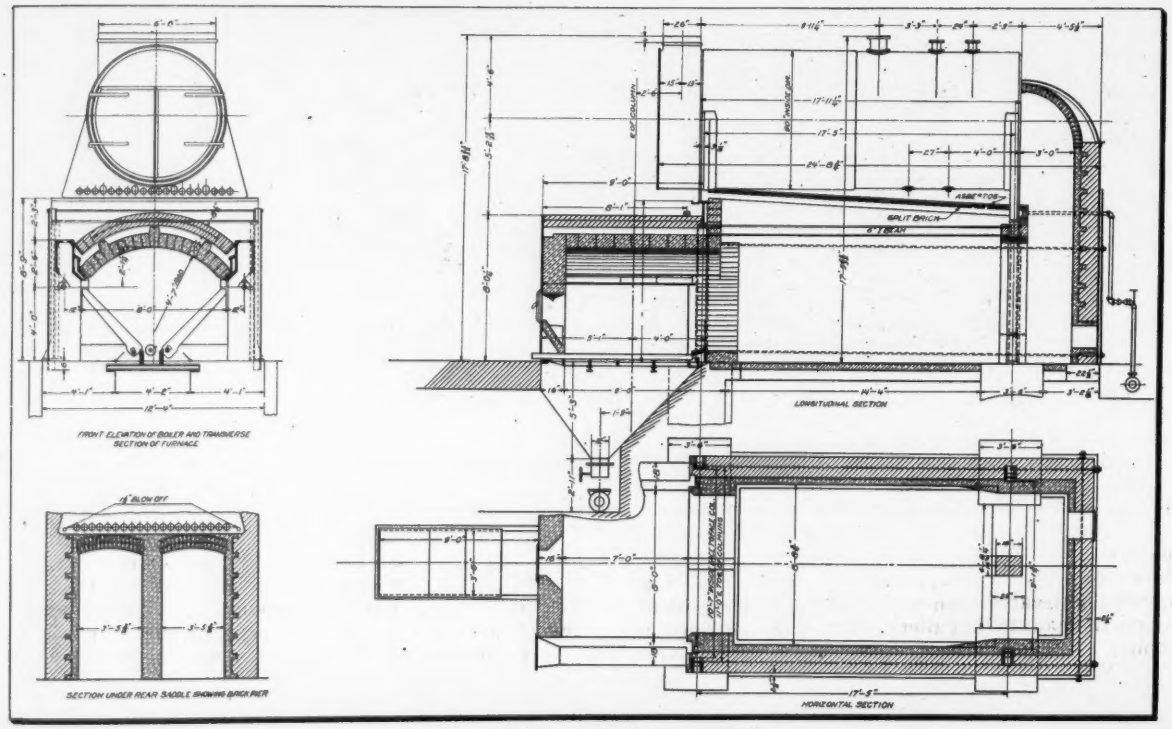
FRONT ELEVATION OF BOILER AND TRANSVERSE SECTION OF FURNACE
SECTION UNDER REAR SADDLE SHOWING BRICK PIER
LONGITUDINAL SECTION
HORIZONTAL SECTION

FIG. 5. DETAILS OF BOILER SETTING

receive the ashes, runs the length of the boiler room and is carried to a receiving hopper on the second floor of the building. This pipe carries the ashes to the hopper whence they fall by gravity to wagons.

Vacuum creating apparatus shown in Figs. 4 and 7 consists of a Connersville vacuum pump driven by belt from a 30-hp. General Electric motor and a dust catcher which prevents, as far as possible, any dirt from going through the blower. This apparatus exhausts the air from the ash hopper on the second floor, the discharged air going to the stack.

The breeching connecting the boilers to the stack is carried above the front of the boiler, increasing gradually in width as it is required to care for more boilers, passing then to the stack which is of steel 9 ft. in diameter and carried above the building in a brick shaft 11 ft. square.

On the boiler room floor beneath are placed the pumps; 2 of duplex outside packed plunger type for house water; 2 of the same type 10 by 6 by 12 in. for feeding the boilers; and 2 simplex vacuum 10 by 14 by 18, for maintaining a vacuum on the heating system all made by the Warren Steam Pump Co.

Steam Piping

PIPING of the plant is the simplest that can be imagined, yet it is effective and convenient. One main header, divided into sections by by-pass gate valves, runs the length of the boiler room at the rear of the boilers, and being blanked at each end, requires no provision for expansion. Boilers are connected to this header by horizontal long radius bends and a short vertical pipe while one long radius bend connects the separator of the engine to the header.

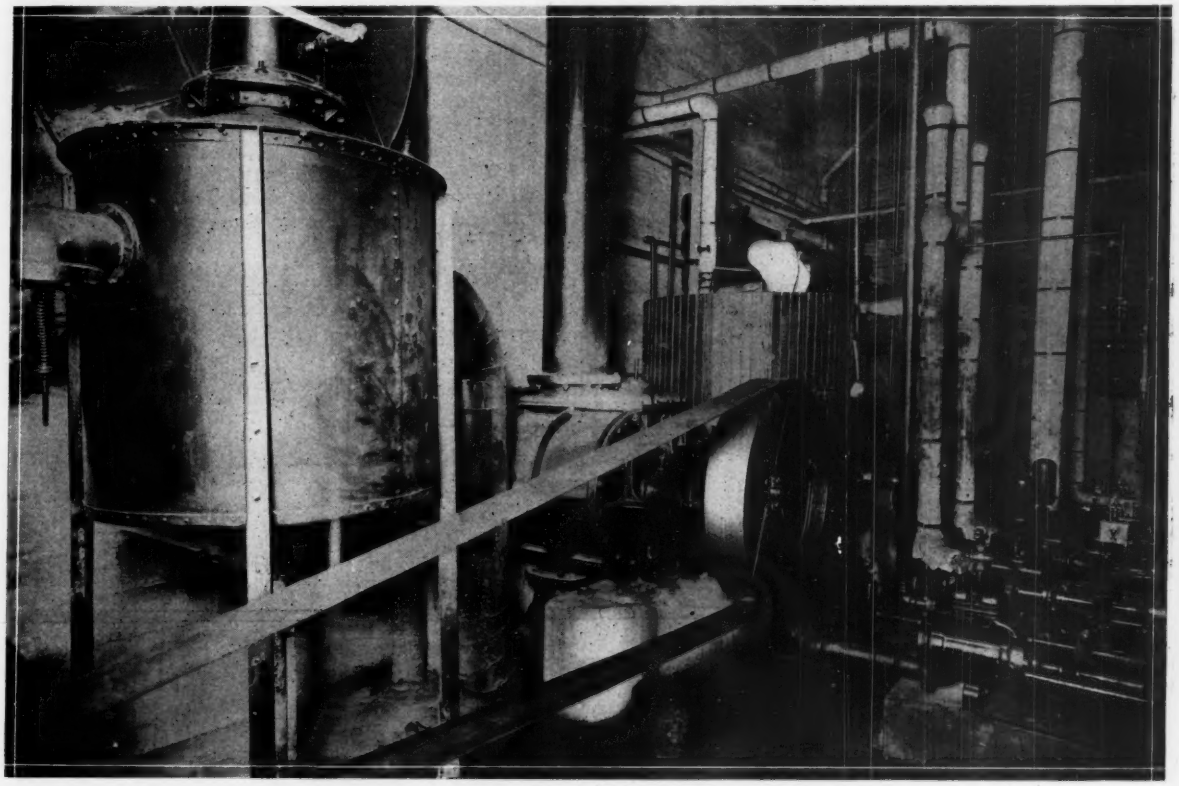

FIG. 7. ASH CONVEYING APPARATUS AND REFRIGERATING OUTFIT

Each boiler is provided with 3 blowoff pipes, in each of which is placed a Homestead blowoff cock; these 3 pipes are connected and discharge into the blowoff header through a Lunkenheimer Duro blowoff valve. The header connects to a blowoff pit and this in turn to a cooling pit which is vented to the atmosphere and also has a discharge to the sewer.

Auxiliary Apparatus

ECONOMY of space becomes an art when applied to power plants for office buildings and in the location of the auxiliary apparatus this feature is probably more noticeable than anywhere else in the plant. Recourse is had to a gallery or mezzanine floor in the boiler room to support 2 house hot water pressure tanks, a No. 4 Stillwell open feed-water heater, a city water surge tank, the expansion tank for the heating system and the receiver tank.

The auxiliary header is run directly above the main header, with several connections between the 2, and furnishes steam for all pumps, also high-pressure steam for the heating system when needed. All high-pressure lines are drained of water at the low points by Vance bucket steam traps.

As the drainage from the plant and all the basement of the building is below the level of the sewer it is necessary to elevate it and for this purpose 2 means are provided. During the daytime the air compressors are running, furnishing air for agitating acids and other purposes about the building, it is essential that the air be free from moisture and oil. As previously stated an oil separator is placed in the line from the compressor to the receiver; from the bottom of the separator, connecting also to the receiver, a pipe is run to a Shone air ejector which

elevates the waste liquids of the basement to the sewer, thus the air is left clean and the ejector furnished with the necessary lubrication from the waste oil in the air line. During night, when air is not being compressed, a Yoeman electric bilge pump serves to elevate the sewage.

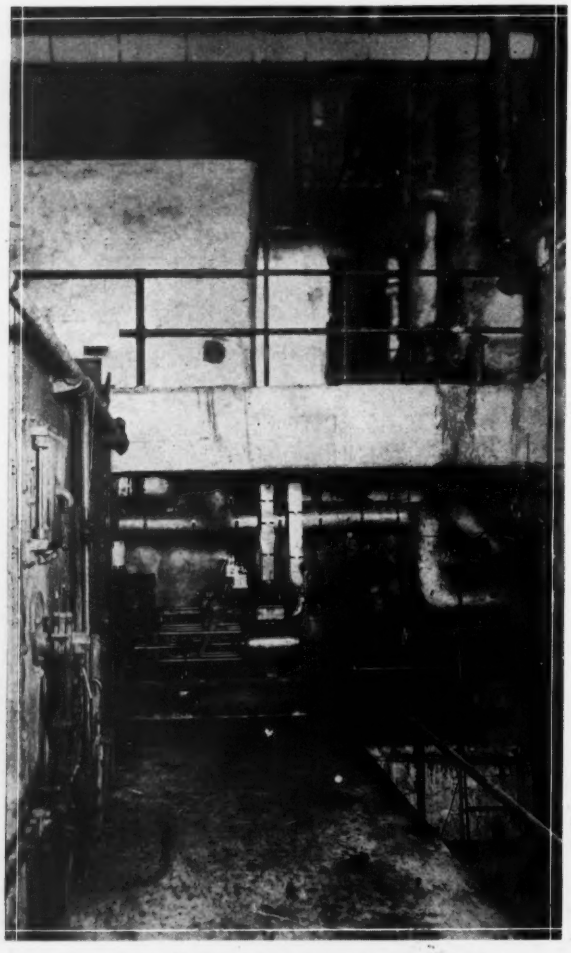

FIG. 8. PUMP AND HEATER ROOMS AS SEEN FROM THE BOILER ROOM FLOOR

Exhaust from the engines is carried in pipes beneath the engine room floor to the exhaust steam header, which is beneath the main steam header, and is then passed through an oil separator to the expansion tank or to the atmospheric exhaust, if the steam is not needed for heating.

Vacuum system of heating is used throughout the building, comprising some 55,000 sq. ft. of radiation. The vacuum maintained is 4 in. with a back pressure upon the engines of ½ lb. While the radiator vacuum valves, as designed by the Illinois Engineering Co., use floats, these have been taken out and by the use of a small quantity of condensing water, not sufficient for make up boiler feed water, the system has been giving excellent results, without the trouble of keeping the floats in working order.

During the extreme cold weather of winter exhaust steam is not sufficient to heat the building and it is necessary to turn in live steam through a reducing valve. The liability, however, of the live steam valve being left open when there is sufficient or more than enough exhaust steam to heat the building and the live steam passing directly to atmosphere through the back pressure valve, led to putting a gate valve in front of the back pressure valve on the exhaust line and a pop safety valve on the receiver, thus when no live steam is needed in the heating system the operator is given warning by the blowing of the safety valve, live steam is cut off and the gate valve in the atmospheric line opened.

Return condensation from the heating system is discharged into the feed-water heater from the receiver, thence it is pumped to the boilers.

After an inspection of the boiler room a drink of cold water from the refrigerating machine was more than refreshing. This cold water is furnished to all parts of the building and no doubt those who are at work making maps of the Torrid region welcome a draught sent direct from the Frigid zone. This zone, however, is created by a Kroeschell ice machine consisting of a gas compressor operated by a 10-hp. West-

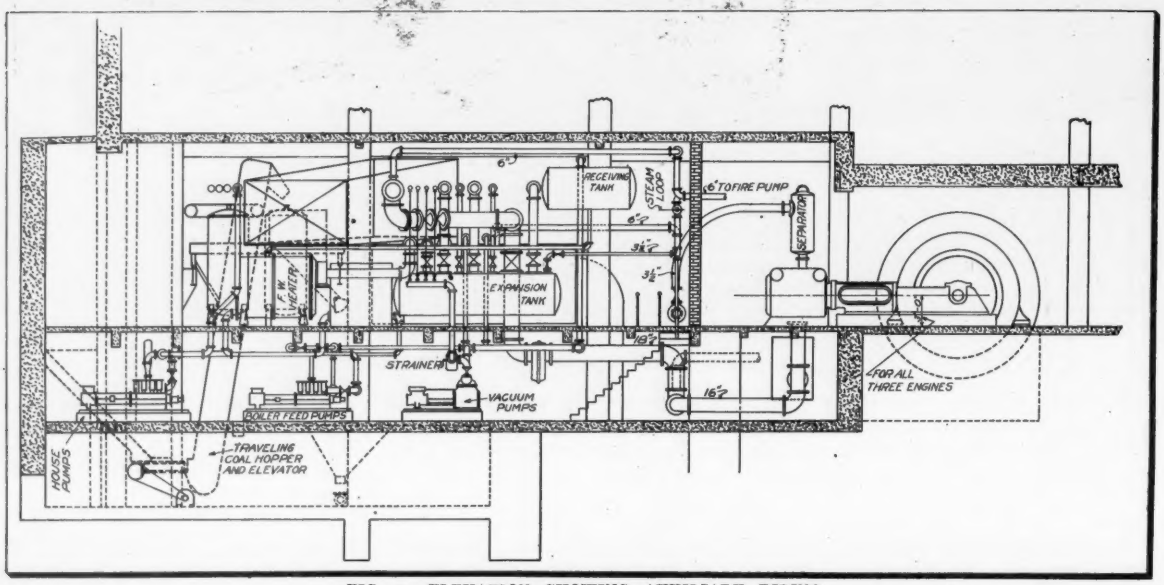

FIG. 9. ELEVATION SHOWING AUXILIARY PIPING

inghouse motor, double pipe gas condenser, a cooling tank, 3 cold water pumps, 1 being for emergency. This outfit is seen in Fig. 7.

Power developed in this plant is used for operating elevators, printing presses and other machines used in the printing industry besides lighting the building, the power load being about half the load on the plant.

Throughout the entire plant an appearance of efficiency and convenience is in evidence; steam piping is all thoroughly insulated, tools and supplies are provided with racks or shelves kept in order, hand oil cans are kept on trays and other details that add to convenience and efficiency of the operating force are not overlooked.

The engineering work of this plant was done by the engineers of Holabird & Roche, Architects, in conference with George Moore, chief engineer of the plant, to whom we are indebted for information and blueprints used in the preparation of this article.

BAROMETRIC CONDENSERS AT COAL MINES

Vacuum of 28 in. with 70 Deg. Water Maintained with Turbines

By Richard Stubridge

THE power station shown in the accompanying illustration is located at Homer City, Pa., and is one of a number of plants throughout Western Pennsylvania owned and operated by the Rochester & Pittsburgh Coal & Iron Co. It is a fair example of the modern tendency toward the generation of power in the heart of the coal regions and the distribution of it through high-tension lines to the surrounding country. The Luzerne plant, as this station is called, furnishes current to the Luzerne Coal Mine, to operate the underground trolleys which haul the coal cars to and from the coal drifts; these drifts are 3 miles and more in length. In addition to this service, current is carried through high voltage a. c. lines to substations throughout the county, where it is transformed for similar purposes in other shafts.

In considering the location of this plant, thought was given as to whether it should be placed near the coal supply or near the water. Owing to the fact that the creek was some distance from the shaft, it was evident that the water could be handled less expensively from a distance than the coal. The loaded cars, on being brought to the ground level, can be run directly into the boiler room and emptied into the coal bunkers, consequently reducing the handling cost to a minimum.

The power house is built of brick with concrete foundation and occupies a space of 100 ft. by 150 ft. It is an imposing building and the 12 steel stacks and 3 condenser exhausts towering above can be seen for miles. The large condenser cones, with their exhaust and tail piping, loom massive in their steel frame work and are a source of much speculation to the many miners and travellers who pass by.

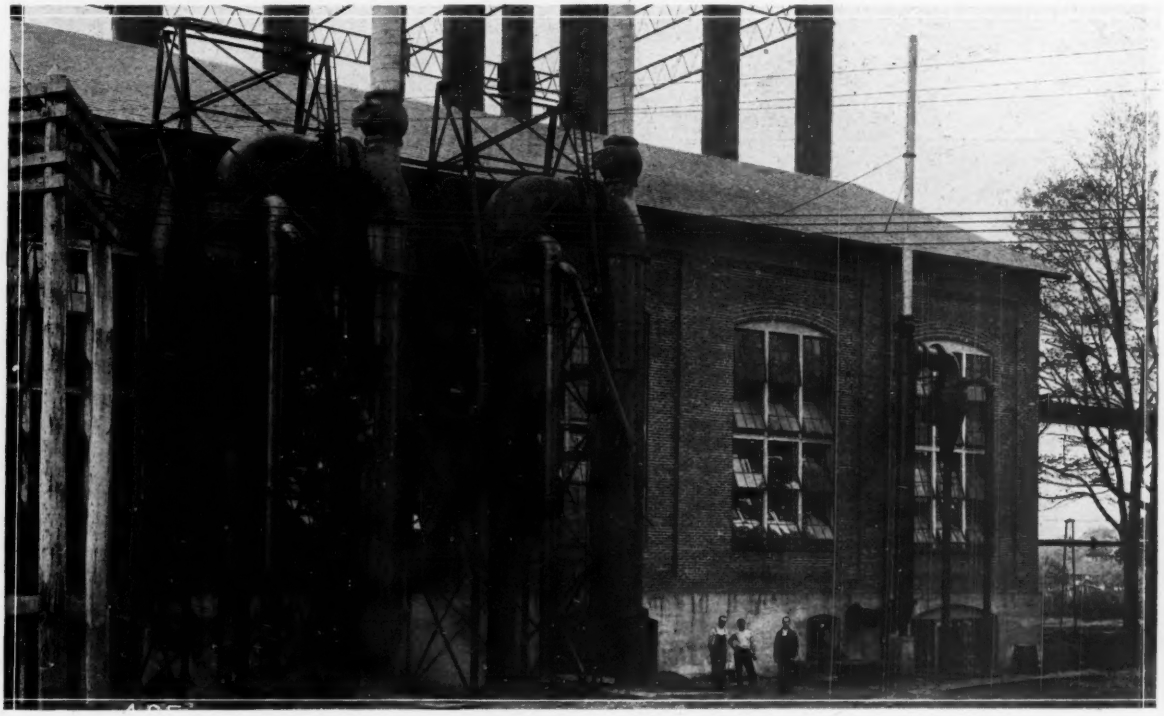

FIG. 1. THE LUZERNE PLANT

Two General Electric Co. 3000-kw. horizontal turbo-generators and an Ingersoll-Rand 2-stage air compressor for operating air drills in the mine are the principal units. To each unit is connected a Wheeler barometric condenser, shown in the photograph, with vacuum breaker and relief valve. Wheeler rotative dry vacuum pumps, of tandem type, remove the air and noncon-

densible gases from the condenser cones; a view of these pumps is given in Fig. 2. At the bottom of each exhaust pipe near the turbine, a direct acting hotwell pump of the suction valveless type handles the condensate not carried into the condenser by the exhaust.

Two centrifugal pumps for injecting cooling water into the condenser were supplied by the De Laval Steam Turbine Co. The water supply is 1200 ft. distant from the plant, so, of necessity, the pumps are on the outboard end of the line, and are driven by motors, current for which is taken from the main supply. To put the condensers into service, that is, to give them water, one of the main turbines must be run noncondensing for a time to furnish power to the pump motors.

The condensing outfits are all guaranteed to maintain 28 in. vacuum with 70 deg. injection water, or to maintain 26 in. vacuum, without the use of an air pump and with a water consumption 25 per cent less than in the first case. These figures were easily bettered in the official acceptance test, and subsequent performances have shown that the outfits are capable of even higher results during long continued operation.

FIG. 2. WHEELER ROTATIVE DRY VACUUM PUMPS

Unfortunately, the exhaust piping is of riveted steel, which is quite unsuitable for high vacuum service, and it is more than likely that if this could have been kept perfectly impervious to the air, unusual results might have been obtained. However detrimental this was to high vacuum, it was undoubtedly of slight importance compared with the fact that an excess of injection water was fed to the condensers.

Formerly, for ordinary engine work with reasonably cold water, and where only moderate vacuum was required, the amount of injection water used was rarely considered, hence little attempt was made to obtain a proper distribution of the water in the condenser vessel; as the demand for large sizes increased, however, and in view of the added requirements of higher vacuum and warmer water, the quantity used became of more and more importance, particularly where the amount available was limited. It will be appreciated that all the water must be pumped against a head due to the difference in height of the condenser and the column induced by the condenser siphon, and that it costs money to pump this water. In addition, a reduction in the amount of water, besides lowering the pumping cost, reduces the amount of air liberated from it in the condenser, and hence reduces the size of the air pump and the load on it.

The Wheeler barometric condenser has been designed to give liberal size to the exhaust steam passages and hence an easy entrance for the steam, together with such distribution of the injector water as will obtain good results with the minimum quantity. It does not perform its best work with more than this minimum amount, and in nearly every case where the initial operation of the condenser has been left to the engineer of the plant, this mistake has been made, with the result that the throat of the condenser is constantly choked, thus cutting down the effective area of the water sheets, preventing the proper operation of the ejector nozzle, and in general, nullifying the good design of the shell which is intended to cover just these functions. In operating condensers of this type, no matter what the make, engineers should experiment until they find the minimum amount of water with which the vacuum will remain stable; they can then be assured of attaining the minimum cost of operation.

POWER PLANT RECORDS

Daily and Monthly Reports for Small Power Plant, Necessary Items and Their Importance for Economical Operation

By J. C. Hawkins

IN these times of close competition between the central station and the isolated power plant, power plant records are of first importance in keeping the efficiency of the plant at its highest point, keeping the central station out, and in the calculation of costs, etc. The systems in use in the large central stations are very extensive and all items are figured out in detail. This is good but the large amount of clerical work attached thereto prohibits its use in many of the smaller plants where the engineer has to be his own bookkeeper.

All plants, even the smallest, should have some form of a daily record of operation of the plant, and after several years' experience in plants where various kinds of records were kept, the one herewith shown was devised as being the most complete of any used and yet not complicated, and may be made to fit various local conditions. The day sheet is 13 by 15½ in., and is filed in a loose leaf file of a suitable size, which may be had with extension pins so that 2 or 3 years' records may be filed in 1 book although I prefer to file each year separately, and at the end of the year have each year's records bound in a volume. The aim of this sheet is to give as much information as possible, and in such a form that it can be readily found when wanted, and makes it possible to see at a glance just what is being done, and with what results.

To illustrate the scope of this chart and make it more easily understood, a plant of 800 hp. is taken as an example, in which there are 4 boilers and 4 engines; the heating system is forced circulation hot water with the heaters using exhaust steam supplanted by live steam in cold weather and live steam for direct steam heating and for the hot water service. There is also a small ice plant, and a vacuum cleaning machine. The general layout is that of an office building. The sheet is laid out for 3 8-hr. watches, but can be changed to 2 12-hr. watches if desired. Under the heading "Data" it is noticed that the outside temperature and condition of the weather are recorded and will go far to aid in keeping the temperature of the water in the heating system at its proper point, any change in the outside temperature

being met by a change in the heater temperature before the temperature of the room changes to any extent.

Steam and exhaust pressure, and temperature of the feed water are necessary items, and a record of the temperature of the hot-water service system may be of value in stopping the complaint of a grouchy tenant. The temperature of the brine in the ice tank should be included as it affects the output of ice, and in a large plant the temperature of the gas in the suction and discharge pipes, and also the cooling water should be taken. The 4 items, "Temperature of flue gas," "Per cent CO_2 in flue gas," "Condition of fire and time cleaned," and "Draught" play a very important part in the economical operation of the plant. It is here that much of the waste in the plant occurs, and even if suspected is very apt to be neglected unless shown up very clearly.

To get this information will require a high reading thermometer or pyrometer, a draught gage and some form of a CO_2 testing apparatus. If a CO_2 recorder

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DAILY REPORT OF ENGINEER

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DATA	FIRST WATCH 7 A.M.	9 A.M.	11 A.M.	1 P.M.	SECOND WATCH 3 P.M.	5 P.M.	7 P.M.	9 P.M.	THIRD WATCH 11 P.M.	1 A.M.	3 A.M.	5 A.M.
Steam pressure												
Exhaust "												
Weather												
Temperature outside												
Temp. Bl'dg heating supply												
" " " return												
" Hot water service												
" Brine in ice tank												
" Feed water												
" Engine room												
" Flue gas												
% CO_2 in flue gas												
Draught												
Fires cleaned - condition												
Volt meter												
Ammeter												
Coal and ashes	Coal		Ashes		Coal		Ashes		Coal		Ashes	
Feed water meter	Read		Used		Read		Used		Read		Used	
Live steam meter	Read		Used		Read		Used		Read		Used	

	START	STOP	HR'S RUN		START	STOP	HR'S RUN
Engine N°1				Boiler feed pump N°1			
" N°2				" " " N°2			
" N°3				General service pump			
" N°4				Vacuum pump N°1			
Fan engine N°1				" " N°2			
" " N°2				Circulating pump N°1			
Boiler N°1				" " N°2			
" N°2				Sump pump			
" N°3				Vacuum cleaning machine			
" N°4				Ice machine			
Fire pump				Coal crusher and conveyor			
Assistant Engineer							
Oiler							
Fireman							
Coal passer							
Other labor							

WATTMETER	NEGATIVE TO-DAY	YESTERDAY	DIFF'C'E	POSITIVE TO-DAY	YESTERDAY	DIFF'C'E				
Unit N°1							Total coal		Total KW. output	
" N°2							Total ashes		Live steam	
" N°3							Total water		Ice pulled	
" N°4							Evap. pr. lb. coal		Oil + grease rec'd	
Power meter			KW.	OTHER Supplies received			Coal rec'd		Ashes removed	

Remarks, repairs, etc.

Chief Engineer

FIG. 1. DAILY REPORT SHEET

is used its readings should be noted here so that all the conditions may be easily compared, and the best combination found. If the fires are given the proper amount of attention, these instruments will soon pay for themselves in the increased economy of the boilers. The voltage and amperes should be read, as it gives a check on the operation of the engines and boilers as well as the variation of the load during the 24 hr.

A careful examination of this report will soon show any variation in the output per unit of input and just where the trouble lies. The weights of coal, ash, and feed water should be recorded at the end of each watch, as it will not only show up any mismanagement on the part of the employes but show at a glance just what conditions will give the best results, and the highest

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Coal used		Cost of coal	
Water evaporated		" of water	
KW. or HP. output		" to operate	
Live steam used		" of repairs	
KW. or HP. hr. power		" pr. KW. or HP. hr.	
KW. hr. lights		" of L. steam 1000 lb.	
Ashes made		" of supplies	
Coal received		" of heat	

Other supplies received

Improvements and new machinery

Condition of plant compared with last month

Remarks:

Chief Engineer.

FIG. 2. MONTHLY REPORT SHEET

evaporation per pound of coal. Where live steam is used to help the exhaust in heating or for any purpose of manufacture, it should be metered or the condensation measured that the proper charges may be made to this use. If used in heating, any increase in the use of live steam consumption in proportion to the temperature and condition of the weather would indicate waste somewhere in the system and would cause an investigation; also, measuring the live steam and deducting it from the total steam made will help to locate any unseen leaks or other source of waste of steam, and divided by the horsepower delivered, will show whether the steam consumption of the engines is as low as it should be. Under the heading "Operation" the time of starting and stopping each piece of machinery is noted, also the hours run. This is desirable as a check on the coal and water used, and for many other reasons, and in case of the boiler the time in operation since last cleaning, etc. If the boilers or other apparatus are in operation 24 hr. a day, without stop, the engineer on the first watch, when starting a new sheet, simply writes the word "on" or makes a check mark in the column headed "Start," and the engineer finishing the third watch marks up "24 hr." in the "Hours run" column.

In this case the generators are the 3-wire system 120-240-v. with the lighting circuit taken from the outside and neutral wires, and the power circuit taken from the 2 outside wires. There is a wattmeter on each side of the circuit between the generator and busbars. There is also a wattmeter in the power circuit, the reading of which is subtracted from the total watt-hour reading which gives the watt-hours required for lighting, which in this case is the larger part of the load. If there were several buildings it might be desirable to have a wattmeter on the circuit to each building. The total amounts of coal, ash, water, live steam, kw. hours, etc., are noted, also the oil and grease, waste, coal and other supplies received. The wattmeters are read, and the totals figured at the end of the third watch, and the meter reading copied on the new sheet by the man coming on the next watch.

Under the heading "Remarks, Repairs, etc.," are noted all repairs, changes, what was done, the material used, and any other information that may be of interest, and signed with the initials of the engineer on duty at the time the repair was made. After the report is filled in and signed by the assistant engineer at the end of his watch, it is examined by the chief engineer or superintendent and signed, then placed on file for future reference. Each individual plant will require a little change in the items noted, but enough information may be had from this sheet to keep the plant in first class operating condition if the information derived therefrom is acted upon.

To make the system of records more complete, and have the matter in such shape that it may be easily gotten at by the chief engineer or superintendent, a monthly report form is laid out as shown in Fig. 2. These are made of card-board and may be filed in a filing cabinet, drawer of the desk or other convenient place. The general conditions of the plant for any one month may be easily and quickly compared with those of any other month. The cost of this system is very little, and as the day sheet is filled out by the assistant engineers or oilers very little time and labor is required to keep an accurate record of the operation of the plant. And any outlay of money for instruments or other apparatus to be used to get this information will, if the information is acted upon soon be saved by the more economical operation of the plant.

TRAP WISDOM

Helping an Overworked Trap; Where 4 Traps Were Better Than One

By W. Simpson

I HAD been experiencing considerable trouble with a high-pressure drip tank overflowing and backing up into the steam system, thereby reducing its efficiency, and, at times, causing severe water hammer. The drip tank was under 55 lb. pressure and acted as receiver for a return trap, that fed the condensation from drying coils and kilns back into the boiler. It was placed only 2 ft. below the lowest point in the kilns. When the steam was turned into the cold pipes, the condensation became excessive and fed into the tank faster than the return trap could take care of it. The difficulty could, of course, have been remedied by

installing a larger tank and a return trap of greater capacity, but, as these periods of maximum condensation occurred only five or six times in twenty-four hours, the cost of a new outfit was not considered to be justifiable, so the following scheme was devised, automatically taking care of the overflow and also at a cost of only about one-tenth of an entirely new outfit.

Into the largest return, a 2-in. line, I put a tee and carried a line over to a non-return steam trap. The discharge outlet from the trap was carried to the hot well for another boiler, so that the excess water was not wasted.

In Fig. 1, R and R_2, are the returns from the steam system, P is the line from receiver to return trap on boiler No. 1. O is overflow from tank through the

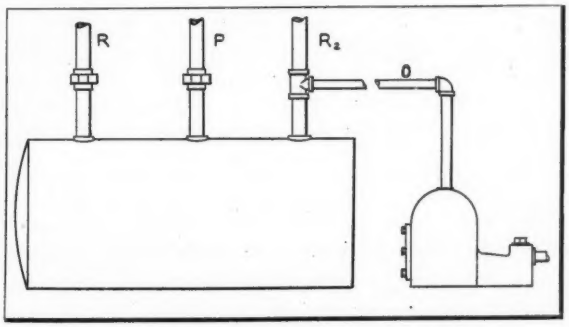


FIG. 1. CARING FOR OVERFLOW FROM DRIP TANK

trap to the hot well at boiler No. 2. The scheme worked to perfection and, since its installation, I have had no trouble with water hammer or a sluggish drain in the kiln.

In this connection I might state that I find that steam traps are one of the best investments in the steam specialty line. In a certain portion of my plant I have fourteen traps which, according to some engineers, is far too many—in fact the title "Steam Trap Bill" was donated to me. To show them that I was not absolutely "dippy" over traps, I ran a series of tests that showed their efficiency. In a row of four dry kilns, each containing 600 sq. ft. of heating surface, I had four traps, one for each kiln, all discharging into the same return line. These friends of mine claimed that only one large trap in the line was necessary, would give the same results, have a lesser first cost, and wouldn't require as much care and attention.

As all of the traps were by-passed, it was a simple matter to cut out the single traps and place a large trap, temporarily borrowed from another portion of the plant, in the main return. In Fig. 2, T_1, T_2, T_3, T_4, are the small traps, each individually draining their respective kilns, K_1—K_4, while T is the large trap taking care of all the condensation from the four kilns, when the small traps were cut out. My results were based on the efficiency of the kilns under the two conditions, first, with individual traps, and, secondly, with a single trap, removing the condensation from the sys-system. As far as possible I endeavored to have the steam pressures identical for both tests, and the amount of moisture to be removed from the material in the kilns the same. There were slight variations, but not enough to affect seriously the results.

I found with the four traps in operation that the kilns did their work in two hours twenty minutes, and with a single trap it took two hours fifty-five minutes, a saving in time of thirty minutes, making it possible to put through the kiln 2.05 more loads in twenty-four hours when four traps were used, so four traps gave the kiln a time efficiency 20 per cent greater than a single trap, but about 6½ per cent more steam was used to make their greater capacity. The greater amount of steam used was due to the additional surface brought in to service by freeing the coils from water.

A great many results of experiments are given, as I have above presented them, in efficiencies or reduction of steam or coal consumption, but to be of real service they must be carried on further, giving results in dollars and cents, and also showing that the investment was a profitable one. In this case I was forced to give monetary results, as the four traps cost $56.00 against $32.00 for a single large one.

The cost of coal, only, for 1000 lb. steam was about 14½ cents, the total amount used in the kiln with one trap being 2800 lb. per hour or 67,200 lb. per day of 24 hr.; with four traps the steam consumption was 71,568 lb., making the cost of steam $9.58 and $10.20 respectively. With one trap the kilns were drawn 8.23 times per day, while the four 10.28 loads were obtained. From these figures the respective costs per kiln load were $1.16 and 99 cents.

With four traps and drawing 8.23 loads per day at a cost of 99 cents, the total amount would be $8.14 against $9.58, on an equal lumber capacity with one trap. Thus we have a saving of $1.44 per day, on an additional investment of $24.00. Furthermore, the four traps paid for their first cost in 38 days.

There may be some who will doubt these results and say that, if one trap sufficiently large was installed, the results would be the same either way. While this would probably be so, if the pressures of each return were identical, an impossibility however in practice, as there were slight differential pressures in each return, due to different rates of kiln drawing, and the subsequent rate of condensation had an effect on

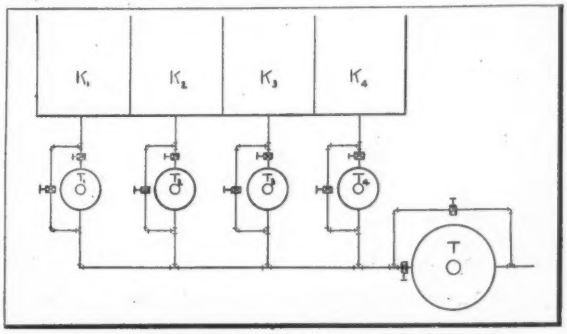


FIG. 2. ARRANGEMENT OF TRAPS DURING TEST

the pressure. The kilns that were nearly ready to draw, i. e., with the material in them practically dry, had the higher pressure and the wet kilns would have the lower pressure, making it necessary for them to collect a head of water sufficient to form a pressure sufficient to overcome the higher pressure of the dry kiln. It was the removal of this water that gave the greater efficiency.

I firmly believe and know, from my own experience, that if engineers would sharpen up their pencils and do a little "figgering" and show their calculations to the "boss" it wouldn't be so difficult to get appropriations for new traps, pressure regulating valves and other automatic devices that seem costly at first, but pay for themselves later.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

PRACTICAL ELECTRICAL ENGINEERING

Calculation of Wiring in Alternating-Current Circuits for Incandescent Lamps and Induction Motor; Power in Alternating-Current Circuits

INCANDESCENT lamps operated from an alternating-current circuit constitute a noninductive load and the formulas for figuring incandescent loads on direct-current circuits are applicable to single-phase alternating-current circuits. The mutual induction, capacity and skin effect encountered in interior wiring, and the self induction where conduit is used are so slight that they can be neglected.

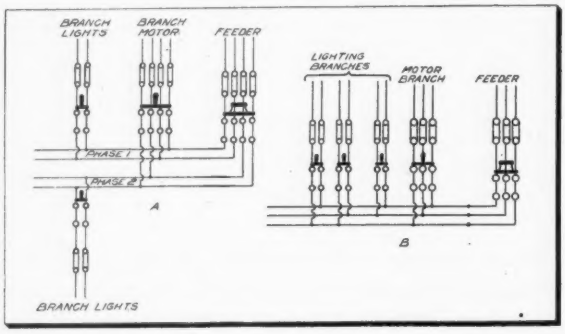


FIG. 1. TWO-PHASE AND 3-PHASE DISTRIBUTION DIAGRAMS

For 2-phase distribution, the arrangement of conductors is shown at A in Fig. 1, with the main feeder controlled by a 4-pole switch and with 1 4-wire branch for supplying current to an induction motor and 2 2-wire branches for lighting service. A similar arrangement for controlling the circuits of a 3-phase, 3-wire system is shown at B, Fig. 1. The 2-wire branches should connect with alternate phases to maintain, as nearly as possible, a balanced load.

$$A = \frac{P \times L \times 746 \times 11 \times 1.5}{E \times e \times X \times pf}, \text{ in circular mils}$$

P = hp. of motor
L = length of circuit in ft.
E = impressed e.m.f.
e = drop in volts in line
X = efficiency of motor
pf = power factor

FIG. 2. INDUCTION MOTOR WIRING FORMULA

To calculate the size of conductors for noninductive load on a 3-phase, 3-wire circuit and a 2-phase, 4-wire circuit, substitute the constant 11 for 22 in direct-current formulas and VI in the Jan. 15 issue, p. 122, and proceed with the operations in the same manner as for calculating the size of conductors for a 2-wire direct-current system.

Another method of calculating the size of conductors for a 4-wire, 2-phase circuit, or a 3-wire, 3-phase circuit is to use formulas III and VI for 2-wire direct-current circuits and divide the results by 2.

Conductors for Polyphase Induction Motors

WHEN determining the size of conductors for induction motors, several factors enter into the calculations that do not have to be considered in connection with direct-current motors. As a rule motors under 5 hp. are started directly from full line voltage by throwing in a switch frequently causing the starting current to be 2 to 3 times the full load running current. Another consideration is that induction motors operating below normal voltage rapidly fall below their normal horsepower rating and are unable to take care of overloads frequently imposed upon them.

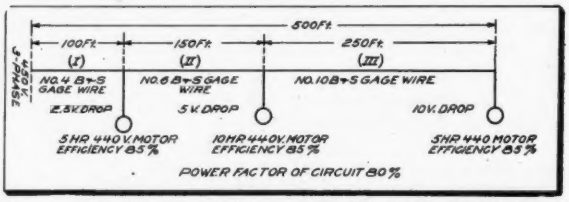


FIG. 3. CIRCUIT DIAGRAM OF 3-PHASE LINE SUPPLYING 3 INDUCTION MOTORS

It is, therefore, good engineering practice to use conductors 50 per cent larger than actually needed for a given load.

The power factor of the motor and the line have to be considered which, if not definitely known, can be considered as 80 per cent with reasonable accuracy for normal working conditions. Of course, the power factor of a system is materially lowered where there are underloaded induction motors in operation and it is always advisable to install motors whose rating corresponds closely to the loads they have to carry. As with direct-current motors, the efficiency of induction motors also enters into the calculations, and the following efficiencies for various ratings can be taken to represent average practice: One hp., 80 per cent; 5 hp., 85 per cent; 20 hp., 88 per cent; 300 hp., 93 per cent.

For calculating the size of conductors to supply current to polyphase induction motors, taking into consideration the various factors considered, the for-

mula in Fig. 2 has been derived. It states that for motors operating on 2-phase, 4-wire, or 3-phase, 3-wire circuits, the required area of the conductor in circular mils is equal to the continued product of the rated horsepower of the motor P, the length of the circuit in feet L, 746, the number of watts to one electrical horsepower, constant 11 and constant 1.5, the latter providing increase in the size of the conductor for the 50 per cent overload; divided by the continued product of the impressed electromotive force E, the drop in volts e, efficiency X expressed decimally, and the power factor pf expressed decimally.

Sample Calculation

LET us assume the problem shown diagrammatically in Fig. 3, which is a 3-phase line 500 ft. long with 450 volts at the switchboard. One hundred feet from the switchboard is located a 5-hp., 440-volt motor with an efficiency of 85 per cent, and it is desired to have a drop of 2.5 volts in the line at this point. At a point 250 ft. distant from the switchboard is located

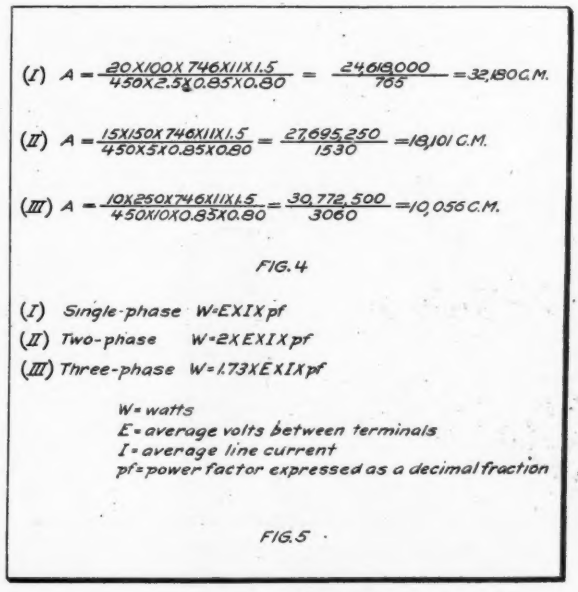

(I) $A = \frac{20 \times 100 \times 746 \times 11 \times 1.5}{450 \times 2.5 \times 0.85 \times 0.80} = \frac{24{,}618{,}000}{765} = 32{,}180$ C.M.
(II) $A = \frac{15 \times 150 \times 746 \times 11 \times 1.5}{450 \times 5 \times 0.85 \times 0.80} = \frac{27{,}695{,}250}{1530} = 18{,}101$ C.M.
(III) $A = \frac{10 \times 250 \times 746 \times 11 \times 1.5}{450 \times 10 \times 0.85 \times 0.80} = \frac{30{,}772{,}500}{3060} = 10{,}056$ C.M.

FIG. 4

(I) Single-phase $W = E \times I \times pf$
(II) Two-phase $W = 2 \times E \times I \times pf$
(III) Three-phase $W = 1.73 \times E \times I \times pf$

W = watts
E = average volts between terminals
I = average line current
pf = power factor expressed as a decimal fraction

FIG. 5

FIG. 4. SOLUTION OF PROBLEMS INVOLVED IN FIG. 3
FIG. 5. FORMULA FOR POWER IN ALTERNATING-CURRENT CIRCUITS

a 5-hp., 440-volt motor with an efficiency of 85 per cent; the drop in voltage at this point is to be 10; the power factor of the circuit is assumed to be 80 per cent.

To figure the size of the required conductors, the first operation is to determine the size to the first motor, with a 2.5-volt drop, which will carry the entire load. The operation is shown at I, Fig. 4. The result corresponds nearly to a No. 5 wire, but as commercial insulated copper wire is available only in even numbers, No. 4 wire should be used.

The size of the wire from the first to the second motor must be sufficient to carry the load of both the second and third motors with a 5-volt drop at the second motor. For operation see II, Fig. 4. As the result corresponds nearest to a No. 7 wire, No. 6 should be selected.

To determine the size of conductor from the second to the third motor, the latter only need be taken into consideration which has a rating of 5-hp. and an efficiency of 85 per cent, the voltage drop to be 10. For operation see III, Fig. 4. The area in circular mils corresponds very closely to a No. 10 B. & S. gage wire.

Calculating Power in Alternating-Current Circuits

WE have already learned that in direct-current circuits the power in watts is equal to the product of the voltage and the current in amperes; also that for single-phase alternating-current circuits the apparent power in watts must be multiplied by the power factor to find the real power; this is expressed in formula I, Fig. 5.

Suppose it is desired to know the power expended in a 2-phase circuit whose power factor is 0.85 and where the electromotive force between terminals is 440 volts and the ammeter reads 8 amperes. This is determined by Formula II, Fig. 5. Substituting figures we have $W = 2 \times 440 \times 8 \times 0.85 = 5984$ watts $=$ 5.984 kw.

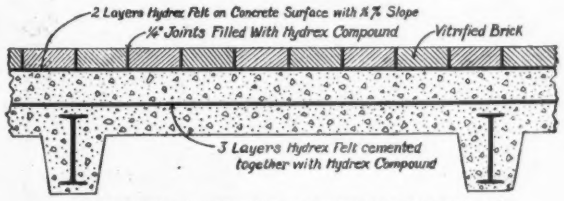
If the voltage between the terminals of a 3-phase circuit is 660, the ammeter readings 6, 8 and 10 respectively, or an average of 8, and the power factor 0.87, what is the power expended? Formula III of Fig. 5 covers this problem; substituting figures, $W = 1.73 \times 660 \times 8 \times 0.87 = 7946.9$ watts or 7.94 kw.

BATTERY ROOM FLOORS

Methods Employed in the construction of Battery Room Floors and How They Are Made Acid Proof

TO make a concrete floor acid-proof, treatment with linseed oil thinned down with gasoline retards the action of the acid but only temporarily.

The general construction of the floor of a battery room consists of vitrified brick or tile placed on concrete base. Leading authorities state that the best way to acid-proof such a floor it to place several layers of acid-resisting felt cemented together with


2 Layers Hydrex Felt on Concrete Surface with ¼" Slope
¼" Joints Filled With Hydrex Compound
Vitrified Brick
3 Layers Hydrex Felt cemented together with Hydrex Compound

SECTION OF A TYPICAL BATTERY ROOM FLOOR

an acid-resisting compound between the brick and the concrete. The correct way to do this is first to give the concrete floor a coating of hot compound, then lay in this several thicknesses of felt, lapped so that the joints of one layer break joints with the under layer. Where this procedure is followed it is unnecessary to use sand for embedding the brick. To protect the walls and any columns in the battery room, it is advisable to turn up the felt for a foot or so at the walls or columns, putting 3 courses of brick against the felt and pouring the compound behind the brick so as to make a tight joint.

The New York Edison Co., which is noted for using large factors of safety in all of its construction, takes extra precautions in acid-proofing floors, usually specifying 2 distinct courses of several layers of acid-resisting felt, cemented together with compound.

In one of the recent specifications of this company for the floors of a transformer and battery station, it is stated that the contractor should spread over the rough concrete floor a layer of 1½-in. cement mortar finished with a smooth surface. As far as acid-proofing is concerned, the specifications were as follows:

"Over the cement mortar surface, shall be laid 3 layers of Hydrex felt, bonded with compound. The cement surface shall first be coated with a continuous and uniform layer of compound, to which it must adhere at every point. Where the felt is turned up on the walls and drain boxes, an additional layer of felt and compound running parallel with the intersection of the 2 plane surfaces shall be applied. Over the completed acid-proof course shall be applied a layer of compound.

"Immediately after the acid-proofing is cool, or soon enough after to insure against damage, the contractor shall spread a layer of cement mortar about 1½ in. thick over the entire horizontal area of the acid-proof course. This will form, after setting, a working surface on which the rest of the work shall be built."

After the protecting layer of cement mortar has set the specifications call for a course of concrete with a cement mortar finish and on top of this a second layer of acid-proofing consisting of 2 layers of the acid-resisting felt with 3 courses of the hot compound. Upon the top of this last acid-proofing course was laid bricks, the joints of which were filled with the hot compound as specified above.

It is interesting to note that the tests of the New York Edison Co., have shown that the felt and compound used in this connection are not at all affected by sulphuric acid solutions.

ELECTRIC MOTOR DRIVE

Description of Reversing Motor Equipment for Planers and Similar Shop Machinery

THE idea of applying reversing motors direct connected for driving planers has been in practice for some 8 or 10 years, though more or less of an experiment up to a year or so ago. The use of this form of drive, even in the first stages of its development, emphasized strongly that it possessed many advantages over older methods of reversing through clutches or belt shifters. Not only is the usual economy effected in the consumption of power through application of the principle of direct-connected individual operation; but maximum cutting speeds are sustained uniformly, acceleration is more rapid on the return travel, and an increased production hitherto unattainable results. The reversing motor drive has ushered in new records in machining castings.

Naturally, the effective performance of this drive has created a demand that has warranted exhaustive study and tests by manufacturers in developing it for commercial purposes. However, perfecting the reversing motor drive for reliable and successful operation has required time, and it therefore can be said to be of comparatively late origin. The General Electric Company has recently placed on the market a reversing adjustable speed direct-connected motor drive that has been carefully tested and tried out in service.

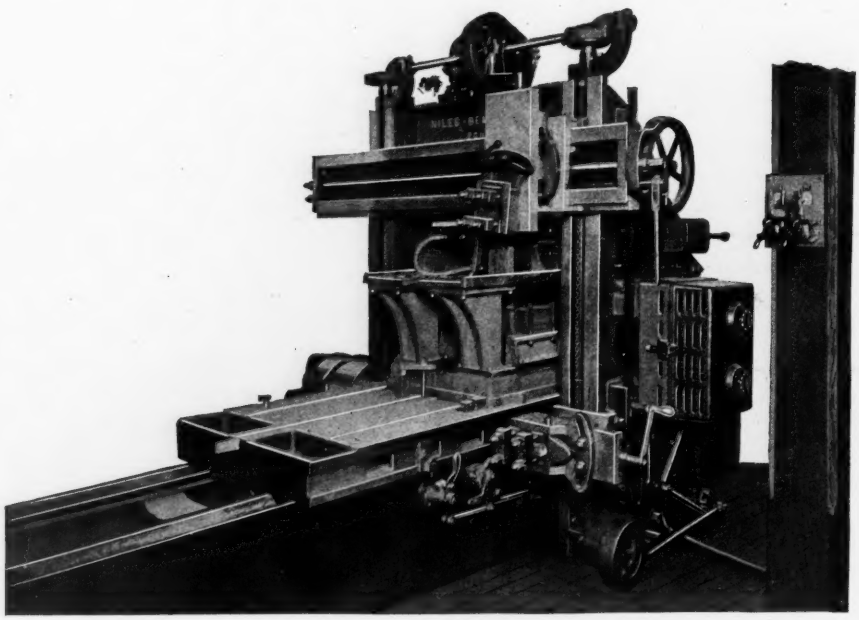


FIG. 1. MOTOR DRIVE ATTACHED TO A PLANER

Probably the most interesting application of this drive to machine tools at the present time is to planers, viewed both in the light of an engineering achievement and from the standpoint of production. That a very large increase in output is obtained with planers through this means is now firmly established and quite generally understood. But the application of the reversing motor equipment in its various forms is almost unlimited. It is now used not only to drive

planers, but also screw, worm and rack driven slotters, turret lathes, wire and tube drawing machinery, and other classes of machines reversed through clutches or shifting belts, which methods are often low in efficiency and high in maintenance.

Motors for this service are mounted in any place on the machine or floor convenient for mechanical connection. They are of the standard commutating pole type with a speed range of 250-1000 r.p.m. at 230 volts, up to and including 100-hp. planer rating. These combinations of speeds allow the motor in the majority of cases to be coupled direct to the driving shaft of the machine.

Control Mechanism

CONTROL consists of a contactor panel and master switch; the contactor panel is usually mounted on the side of the planer housing, or in any convenient place on other machine tools to which the drive may be applied. The panel is made up of 8 contactors. similar in appearance to a series contactor, but actuated by shunt, series or differential coils in such a manner as to eliminate entirely electrical disk interlocks. An additional precaution is taken by using mechanical interlocks to prevent the possibility of short circuits. The panel, field rheostats and all accessories are enclosed in a cast-iron box, the cover of which is hinged, so that when swung open the contactors are easily accessible.

The box itself is pivoted about liberal openings in order that the rear of the panel may be swung into view for inspection when required. The leads are carried through these same openings from either top or bottom, which prevents them from chafing when the panel is swung out. The field rheostat handles are brought out through the cover of the enclosing case and are plainly marked, "Cut" and "Return." The pointers of these handles traverse a blank ring, which can be marked or graduated for cutting and return speeds in feet per minute.

The master switch is generally mounted on the side of the planer bed, or in other convenient place. The switch contains but 4 contact fingers, 2 forward and 2 reverse, one being used in common for both directions, and 3 segments on the drum. Its sole function is to close the shunt coil circuits ot the forward and return line contactors. The motor field is entirely external to the master switch. The panel is encased in a stout cast-iron box, so arranged that the parts and the wiring are most accessible. The master switch is operated by dogs on the planer table in much the same way as is now employed for shifting belts. A special double pole circuit breaker is also supplied, which provides for minimum voltage and overload protection. In case the breaker opens or current fails through any cause, it automatically stops the motor, preventing the platen from coasting off the ways.

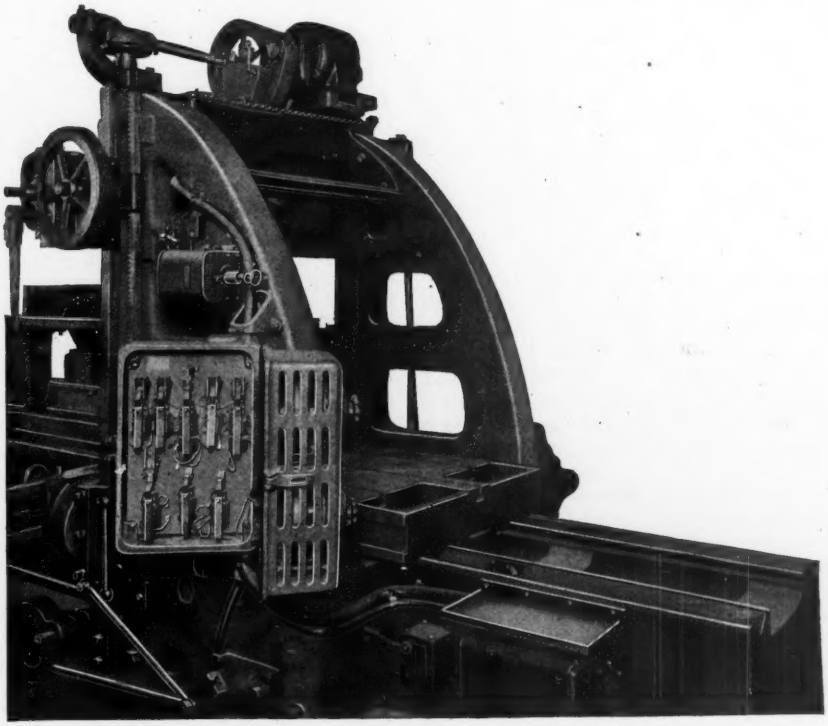


FIG. 2. INTERNAL ARRANGEMENT OF CONTACTOR PANEL

Reversing

BY virtue of the commutating pole design of the motor, starting, stopping and reversing are accomplished with sparkless commutation. In order not to break dynamically from high speed in one violent step, means have been taken to accomplish this in 3 distinct steps, braking down slowly from high speeds and then quickening the brake action at lower speeds. This could not be accomplished with one step of resistance; for at the lower speeds the breaking action becomes almost nil, dragging out the process unnecessarily. Thus, the entire braking is completed in the shortest possible time without undue shock. This feature, in addition to quickening the brake, will be recognized as a decided advantage in the maintenance of the machine.

After voltage failure with the master controller in the running position the motor will start up in the regular way upon return of the voltage to the line without complications by closing the breaker. This operating characteristic is very desirable. Cutting and return speeds are entirely independent of each other, so that it is possible to use the slowest cutting speed and the highest return speed, or vice versa, in any combination not exceeding 4 to 1, with 35 to 70 cutting speeds and the same number of return speeds, depending on the size of the equipment.

In the event of attaching the reversing motor of machines already in use, the speed of the driving shaft on the majority of planers will be low enough with the slowest cut to meet the motor speed of 250 r.p.m., and only a coupling and the necessary motor foundation will be needed. If, however, the planer gearing is of such ratio that the speed of the driving shaft, when making the slowest cut required, is lower than the motor speed, 250 r.p.m., an intermediate gear and pinion have to be installed for the reduction. In the latter case an outboard bearing should be provided, which can be taken care of either by motor shaft extension, or, if the standard motor shaft be used, by a special pinion with shaft extension for outboard bearing. Where the motor is coupled direct to a planer shaft driving through bevel or worm gearing, provision should be made for taking care of the thrust.

Suitable planer dogs are furnished in each instance. Should there be a boss or web directly behind the position of the operating lever, the bracket supporting the lever can be extended and mounted on a strap suitably bent for the purpose. The complete equipment comprises the circuit breaker, motor, contactor control, with pendant switch if desired, master switch, 2 dogs, main operating lever, auxiliary operating lever and bearings for the auxiliary shaft. On account of variance in location, bends and length in individual machines, the auxiliary shaft and the connecting rods from this shaft to the operating lever and master switch are not included.

MACHINE TOOL DATA

Machine		Type Drive	Size Motor H. P.	Input Amp.	Cut In.	Stroke	Not Cutting		Cutting		Return		Cut Total Cycle Sec.
Type	Size						Ft. per Min.	Time Sec.	Ft. per Min.	Time Sec.	Ft. per Min.	Time Sec.	
Planer	36″x10′	Belt	10	33	¼x⅜	8′6″	31.9	16	28.3	18	72.8	7	25
Same	same	Reversing	same	51	same	same	53.2	9.6	52.7	9.8	91	5.6	15.4
Same	same	Belt	same	38,5	¼x⅜	same	33.3	15.4	28	18.2	72.8	7	25.2
Same	same	Reversing	same	56	same	same	53.7	9.5	53.2	9.7	91	5.6	15.3
Planer	72″x22′	Belt	40	95	¼x⅜	10′1″	22.9	26.4	17.1	35.4	59.3	10.2	45.6
Same	same	Reversing	35	120	1x⅜ same	same	34.8	17.4	34.4	17.6	73.7	8.2	25.8

Data of Operation

IT is interesting to note comparatively what has been accomplished with this type of reversing motor drive. As a general proposition, the saving arising from applying power direct to machine tools is considered the amount of friction load which has thus been eliminated. This often reaches as much as 50 per cent., yet it is in reality only a small part of what may be realized, as proved by numerous tests. A belt-driven planer, or other machine, of approximately 10 hp. capacity, running at a cutting speed of 25 ft., will drop in speed 2½ to 5 ft., or 10 to 20 per cent., while cutting to a value of 10 hp., if this approach the carrying capacity of the belt, due to size, speed or slackness. If the cutting speed be increased to 50 per cent with the same depth of cut and feed, the speed will fall while cutting to nearly what it was originally, the power input increasing only slightly or to the limit of the belt capacity. The maximum slip will be reached when the machine is stalled, the power input remaining approximately constant and the loss being entirely due to friction from belt slippage. This slippage loss is demonstrated in the tabulation of tests made with a recording ammeter and given herewith. The motors used were all 230-volt. The speeds noted are average feet per minute for complete cutting and return strokes.

Briefly summarized, the salient operating features claimed by the manufacturer for the reversing adjustable speed direct-connected motor drive are: maximum cutting speed sustained uniformly, affording greatly increased production; rapid acceleration on the return stroke; reverses remarkably close to a line at the end of the cut; very economical operation and upkeep; any speed desired within a ratio of 4 to 1; many speed combinations, allowing the slowest cutting and highest return speed to be combined; freedom from shocks, permitting the quickest reversals possible without jar; quiet operation; sparkless commutation, and positive and safe control within easy reach of the operator.

THE MAN WHO READS was placed in charge of one of our modern automatic stationary engines. The valve, and what was inside of the steam chest and cylinder, he had never seen, and, of course, knew nothing of its construction. He sent to the builder and procured a "descriptive catalogue," and in one evening, by its perusal, he obtained a good idea of what was going on inside of that engine.

The man who does not read wonders what is inside, but does not find out until it is torn apart, and even then he does not get the builder's idea, and know why it is so made. It takes him weeks, months, or years to find out what a few hours of study would enable him to ascertain.

We know of a man holding a high official position on one of the largest railroads of the West who built, at a great expense to the company, a hydraulic piledriver, which, with two men, was to do the work of a 10-hp. engine. He had seen the tremendous force exerted by a hydrostatic wheel press, and concluded that this was just the power to lift a piledriver ram, and as the pump was so small, two men could easily work it. It is needless to add that the result was a failure, and an addition to the scrap heap.

This is a fast age, and the man who expects to keep pace with the times must not expect to find out everything by the slow coach of experience, but take advantage of the delving of others, as it may be condensed in their writings. It saves time, hard work and many mistakes.—Railway and Locomotive Engineering Magazine.

STEAM IN A SUGAR CANE FACTORY

Fuel Used, Proportion of Machinery and Control of the Steam

By W. A. T. Willink

In a sugar cane factory, steam is used for the different engines and other machinery, and also to heat and evaporate the different sugar liquids. This necessitates having a large water capacity in the boiler, so that plenty of steam will always be available. For boilers, the 2-flue and multi-tubular have given excellent results, especially as moderate steam pressures, usually not over 100 lb., are sufficient. But on account of convenience of transportation, the different water tube boilers are now often installed.

Fuel

There is always begasse, or refuse, left after the mills have extracted the juice from the sugar cane, and in a well controlled factory there will be enough so that wood, which is the next cheapest fuel, although being high in price, is used only to start the fires and for heating the juice.

On an average begasse consists of 46½ per cent fibre, 4½ per cent sucrose and 47½ per cent moisture, although these percentages depend on the quality of the grinding and of the cane. A common rate of burning is 70 lb. of fuel per square foot of grate per hour, or 2 lb. per square foot of heating surface per hour. Under these conditions the equivalent water evaporation from fuel at 212 deg. F., is 172 lb. per square foot of grate surface per hour, or 5 lb. per square foot of heating surface per hour.

The physical character of the fuel influences its heating value. The heat in a pound of begasse is 8325 B.t.u., or in a short ton of 2000 lb. of cane, the heat value is found by multiplying 8325 by 2000 by the per cent of fibre, and dividing by 7.223 times the percentage of sugar and by 100. This process gives the heat generated by burning the begasse, not that available for use in the boiler, as the moisture in the fuel must be evaporated and heated to the temperature of the stack gases. For instance, in a fuel containing 50 per cent moisture, the heat per pound of the wet fuel will be 4162, the heat available, 3563; in this case 3.9 lb. of the wet fuel is equivalent to 1 lb. of coal having a heat value of 14,000 B.t.u., and the estimated temperature of the fire will be 1870 deg. F.

If 80 per cent extraction from the main is secured, there are 400 lb. of begasse per ton of cane, and the coal equivalent per ton of cane will be 119 lb.; the coal ratio for 80 per cent extraction is 3.43 lb. of wet begasse equal to a pound of coal. If moisture is over 50 per cent, the fuel will not burn well but smoulders and smokes from the incomplete combustion. All this shows the necessity for getting the proper extraction in order to have good fuel, so that the engineer in a cane factory must pay great attention to the grinding and extraction of the sirup. This involves careful regulating of the setting of rollers and trash turners, according to the quantity and quality of cane handled; and this essential knowledge is difficult at first, because the engineer can only find it out by experiment.

Next to having good fuel, it is necessary to get proper combustion. Evaporation of the moisture in the fuel must take place aside from the combustion, and leave enough heat for useful work. A high temperature must be obtained to get complete combustion, and the gases must be entirely burned before they reach the boiler surface. For this reason the begasse furnaces are all of the extension type, receiving the fuel from a conveyor on the front top. This conveyor feed must be carefully regulated and given strict attention by the engineer. The furnace is rectangular in shape, of various widths and depths, according to the boiler capacity and the quality of the fuel. The roof is arched, and the entire interior lined with fire brick. Grates are often in step form, with an arch above them, which prevents the gases from going through the feed opening, and reflects the heat on the fresh fuel to dry it. Movable steps bring the fuel gradually up to the grate level. When a level grate is used, it is of the hollow blast type, air entering through holes which are covered by a sliding plate so as to control the air supply and keep the holes from clogging up when wood is used as fuel. Force draught is not desirable. Supplementary air supply comes through the side walls of the furnace and the firing doors, and ash pit doors are sealed when force draught is used.

In some furnaces the step grate is omitted and the fuel falls direct from the fibre into the top of the furnace on to a horizontal grate. But this does not work well, as the wet fuel lowers the temperature in the combustion chamber.

Feed Water

In a cane sugar factory the feed water is collected in a large hot well, into which all the drip pipes from the traps and drains from the sugar boilers empty the condensation, although the condensation from the boilers should be pure distilled water. It often happens that spurs of sugar are brought over, and this must be carefully watched, as sugar in the boiler means trouble, making the water foam and causing corrosion of the tubes and sheets. This effect does not always show at once, therefore the boiling apparatus should be so designed that boiling over is impossible. In one plant where there were 5 boilers, every care was taken to obtain pure water —oil separators being installed wherever there was a chance for impurities, although the condensed water from the exhaust steam receiver was not used. At the start of the crop 2 tubes in boiler No. 3 were leaking. This boiler was cut out and the tubes replaced, those taken out showing corrosion and one even having a hole clear through. On examining the drums, those on top were in good order but those at the bottom showed spots. The plates were a little greasy, but not enough to be of importance, and besides the oil used contained no acid.

After a few days' operation, a tube in No. 4 boiler commenced to leak, and it was replaced, and during the run, 6 tubes were replaced in No. 3 boiler, 9 in No. 4 and 2 in No. 2. Boilers 1 and 5 gave no trouble. After the crop was made, all boilers were examined and it was found that in all of them the tubes showed corrosion, as well as the mud drums. Only twice during the run had spurs of sugar been discovered, and the water was then changed at once, although the gage glass never showed dark. The corrosion in

the boilers showed, however, that some organic substance had come into the boiler with the feed water, had been disassociated by the heat and affected the boiler. The brown, soft dust, looking like brown coal-dust, is a sure sign that the corrosion was caused by acids from the sugar. This dust is called "sugar coal," and consists of the organic matter of the sugar mixed with iron rust. If there is danger that sugar has boiled over, the feed water should be neutralized with soda, or not used at all. The best plan is to have sugar boilers of triple or quadruple effect, which give much better distilled water; and feeding the boilers with the raw water is apt to produce heavy scale.

Smokestack

THIS is usually of heavy steel plate which is not expensive and can sway with the hurricanes and earthquakes, frequently experienced in the tropics, without cracking. The stacks should always be made with extra capacity beyond immediate requirements, to allow of the extensions to the factory which are sure to occur. Each boiler should have its separate damper in the uptake, so that it may be cut out of operation when required. The draught necessary to burn begasse is from ¼ to ⅝ of an inch, provided sufficient grate and heating surface are installed. Force draught is not advisable if there is plenty of heating surface, but sugar factories use force draught as it gives a higher evaporation per square foot of heating surface per hour. The moderate stack draft will, however, give more steam per pound of fuel, and this is important as fuel cost is high.

Steam Piping

THIS should not be too large, although the fact must be taken count of that the factory often has to work with only 50 lb. steam pressure. A velocity of about 60 ft. per second is a good figure. The ordinary provisions for pipe covering, traps, separators and expansion bends should be taken the same as in any plant. The exhaust steam is used for heating and evaporating, and ordinarily is laid to a steam receiver for convenience in distribution. There is little occasion to use economical engines, as more steam is needed for the evaporators than comes from the engines; so that if a Corliss engine is used in a sugar factory, it is more a fashion than a necessity. With careful management the begasse from the mill is just about sufficient fuel to make the necessary steam, and as wood is expensive, the engineer must take every precaution to have the begasse furnish all power needed, and even have some left for heating the sirup. It is his business, therefore, to have a good knowledge of the steam used in different engines and pumps, and also of the steam needed in the rest of the plant. So long as exhaust steam is available for heating and evaporating, the use of live steam should not be allowed. This is an important point, because the sugar boiler usually thinks that live steam will make his evaporation pan and still work quicker than exhaust steam. The facts, of course, do not warrant this, but nearly all sugar boilers will try to use all the live steam possible, letting the exhaust steam escape from the discharge pipe to the roof. Often, however, the mill engine may stop for lack of steam. In such cases the engineer is master of the situation only when he can give a clear account of the steam produced and used, so as to show the waste by the sugar boiler. A convenient apparatus in this connection is an automatic pressure regulator, consisting of a chamber with a float; this float operates valves for live steam inlet and outlet, and also for exhaust steam outlet. A small water tank is installed at a height to give water pressure corresponding to the pressure desired in the exhaust system. This water pressure lifts the float in the chamber and operates a double seated valve, permitting live steam to enter the chamber. Steam will enter so long as the pressure in the chamber is less than the water, the float will be forced down, closing the live steam valve. If the exhaust steam goes in to raise the pressure still further, the water will be forced back up the tank and the float will drop still farther, opening a valve through which the excess of the exhaust steam can escape.

Steam Consumption

THE easiest way to obtain data on the consumption of steam is by the use of some steam meter, such as the General Electric, which can be connected in different pipes, determining the amount flowing at each point. In this way a steam balance sheet can be made up the same as a heat balance. If this method is used to find the steam for indicated horsepower in an engine, the flow at the time that an indicator diagram is taken is not a safe index; but average readings should be taken of the steam velocity for an hour or more, and indicator diagrams taken every 5 or 10 minutes throughout that period. Then the average steam flow divided by the average indicated horsepower will give the correct steam consumption per indicated horsepower.

If no meter is available, the steam consumption must be calculated from the indicator card and the boiler pressure. To give an idea of the steam used in a cane sugar factory, the following data will suffice:

Pressure .....90 lb. gage.
Steam used in the mill and crusher engines...
..... 16,910 lb.
In a juice pump, 7 by 7 by 10 in. ....139 lb.
A second pump, 8 by 8 by 10 in.....134 lb.
Desiccators .....1521 lb.
Air compressor, 10 by 11 by 16 in.....551 lb.
Heating tank coil .....661 lb.
Steam at filter presses .....397 lb.
Feed pump, 7 by 5¾ by 10 in. .....595 lb.
Cold water pump 4¾ by 3½ by 6½ in...66 lb.

The total of this is 21,104 lb., and the exhaust steam available, 16,672 lb.; the balance necessary being live steam. Other machinery about the plant called for 14, 800 lb. of steam, which was furnished by a separate set of boilers.

ACCORDING TO THE MECHANICAL WORLD, paint which indicates changes of temperature by a change in color can be made by a mixture of 7 parts of saturated solution of potassium iodide with 134 parts of saturated solution of mercury chloride with 1 part of pulverized copper sulphate and the necessary oils and driers. The paint changes its color between 115 and 130 deg. F., and can be applied to any surface of which it is desirable to determine the temperature. The range of temperature at which the color-changes take place may be slightly varied by altering the proportions of the ingredients.

IN SWITZERLAND, whose area is about ⅓ of that of Pennsylvania, are approximately 2800 miles of railway, of which 103 miles or about 3.7 per cent of the total is in tunnels. No less than 9 of these are more than 5 miles long, the total number of tunnels being 415.

FOREIGN DEVELOPMENT IN THE POWER PLANT FIELD

Increasing the Efficiency of Turbines by the Use of an Escapement Disk

By J. H. Blakey

IN the "Revue de Mecanique" for June 30, M. Delaporte studies the working principles of various turbine accessories, and shows that in most modern turbines the vacuum which is obtained in the condenser is not entirely utilized, because the total sectional area of the passages offered to the steam in the last disk can not be sufficiently increased without entailing an increased cost of production, which with the present keen competition would be prohibitive. Consequently a part of the energy contained in the steam is thus lost.

The author goes on to describe a means of recovering a part of this energy by placing after the last turbine disk, another having a sectional area of passage equal to this, and called an escapement disk. Between the vanes of this disk is allowed to pass only a part of the steam leaving the turbine, so as to allow it to be expanded to the lowest limit allowed by the condenser. By this means there is a loss of only part of the energy of steam escaping at too high pressure.

The author states that by the addition of such an escapement disk an increase of efficiency amounting to 4 per cent of the total power of the turbine was observed in the case of a turbo-generator of 1500 watts, running at 3000 r.p.m. and using 6.9 kg. (15 lb.) of steam an hour.

Carburetor for Gasoline and Petroleum

THIS new invention consists of an arrangement whereby 2 kinds of fuel of different density, such as gasoline and petroleum, can be used simultaneously in any desired proportion. It consists of 2 separate jets mounted side by side within a choke tube of comparatively small bore, standing in the center of, and communicating at the top with, the mixing chamber. Each jet is fed from a separate float chamber in the ordinary way.

Shaped somewhat like an inverted mushroom valve with a hollow stem, and mounted on the central choke tube A, is an air valve, B, which is held to its seat by a suitable spring and is opened by the suction of the engine. The movements of this air valve are damped by a dashpot which is formed by the inner face of its stem and the outer face of the choke tube. At its top the stem carries a bridge piece in which 2 tapered needles are adjustably mounted. They extend downwards into the openings of the jets, and following the movements of the valve they increase or decrease the jet orifice in proportion to their taper and the amount of lift. The former, of course, is a matter of initial adjustment, while the latter is regulated by the engine speed.

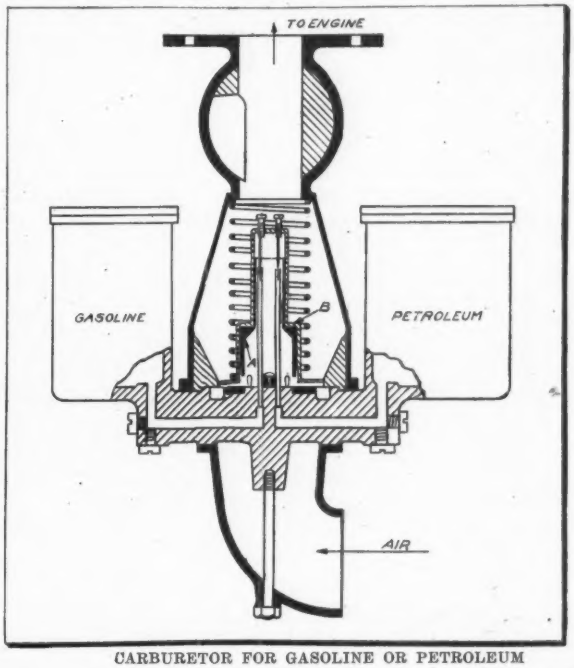
With the main air valve in its normal or closed position the needle controlling the petroleum jet is screwed down so as to shut off the fuel entirely, and the needle controlling the gasoline jet is adjusted to allow the passage of just enough fuel to form an explosive mixture with the small amount of air passing through the choke tube when the engine is running idle. Thus we have virtually a small gasoline carburetor sufficient to feed the engine when not under load, and also sufficient to start up from cold.

As soon as the throttle, which is of the rotary drum type, is opened, the increased suction creates a vacuum in the mixing chamber which the small amount of gas passing through the central choke tube is unable to fill. The air valve is consequently lifted from its seat and admits sufficient air to supply the increased demand of the engine; but the rising air valve not only admits the required amount of air, but carrying the two taper needles with it, the jet orifices are opened and allow such a quantity of fuel, both gasoline and petroleum, to pass as is in exact proportion to the amount of air admitted by the valve.

The makers claim that if the whole length of the induction pipe, or at least a good part of it, is heated by a hot water or exhaust gas jacket, the carburetor will deliver a correct mixture consisting of 60 per cent of petroleum and 40 per cent of gasoline.
of petroleum and 40 per cent of gasoline.—La Science au Siecle.

Nonconductors of Heat

AT the second French Refrigeration Congress held at Toulouse, in September, Mons. M. K. Biguard gave the results of his researches upon the heat conducting power of the following heat insulating materials; these researches having been made by him at the Conservatory of Arts and Siences:



CARBURETOR FOR GASOLINE OR PETROLEUM

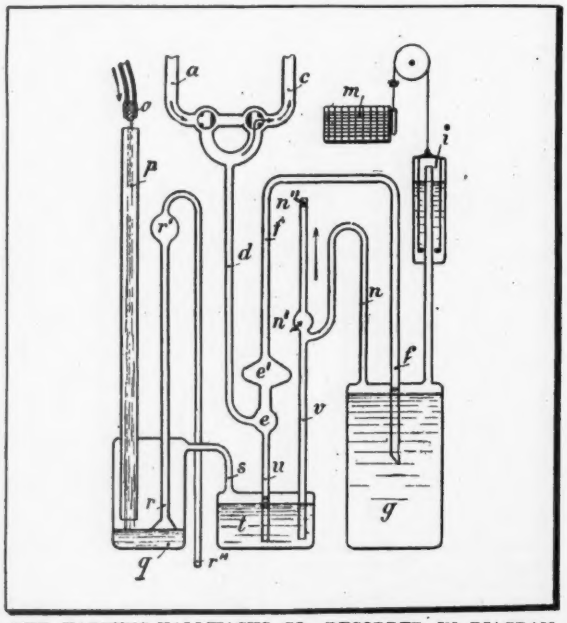
Insulators	Coefficient of Conductivity
Kapok (a vegetable wool of Java)	0.034
Cork in grains	0.040
Cork agglomerated with casein	0.044
Charcoal (wood charcoal dust)	0.045
Cork agglomerated with tar, dry	0.052
Pasteboard, corrugated	0.052
White asbestos fibers	0.054
Asbestos pasteboard, corrugated	0.072
Cork agglomerated with tar, moist	0.076
Cork agglomerated with casein, moist	0.088
Compressed cellulose	0.210
Bricks of asbestos and plaster	0.350
Bricks of iron slag	0.400
Compressed asbestos	0.220
Stone	0.430

CONTROL OF COMBUSTION

Regulating the Carbon Dioxide According to the Automatic Record of the Boiler Furnace Conditions

By Francis G. Wickware

In a recent issue of the Praktische Maschinen-Konstrukteur, is described a new device, known as the Hartung-Hallwachs apparatus, for the continuous automatic indication of the efficiency of combustion in boiler furnaces. The apparatus is designed to take at regular intervals a sample of the flue gases, to remove the CO_2 by absorption, and to measure and register the residue. The apparatus is represented schematically in the accompanying figure.



THE HARTUNG-HALLWACHS CO_2 RECORDER IN DIAGRAM

Tubes a and c are so connected with the flue that a continuous current of gas passes through them. At regular intervals, a certain amount of gas is drawn through the tube d into the bulbs e and e', whence it passes by the tube f to the vessel g, which contains the liquid for the absorption of CO_2. The residual gases are collected in the bell of the gasometer i; their volume is indicated by the height of the bell, which is registered on the cylinder m, operated by clockwork.

Sampling of the gas, its movement through the various tubes, and the clearing of the gasometer of the residual gases, are accomplished by quite simple means. The bulbs e and e', communicate with the tube u, the lower end of which is immersed in a non-absorbent liquid in the vessel t. This vessel is connected, through the tube s, with another vessel g, into which water flows continuously through the tube p and which contains one branch of a siphon r, r', r''. Water rising in q compresses the air and forces it into the vessel t. The liquid in t rises in the tube u, fills the bulbs e and e', and forces the gas contained in them toward the vessel g.

When the water reaches a certain level in the tube p, the siphon is primed, and as its discharge is greater than that of the tube p, the pressure is reduced in q until the liquid returns to the vessel t, and a sample is drawn in through d to fill the vacuum created in e and e'. The flow of the siphon is then stopped automatically and the same cycle is repeated.

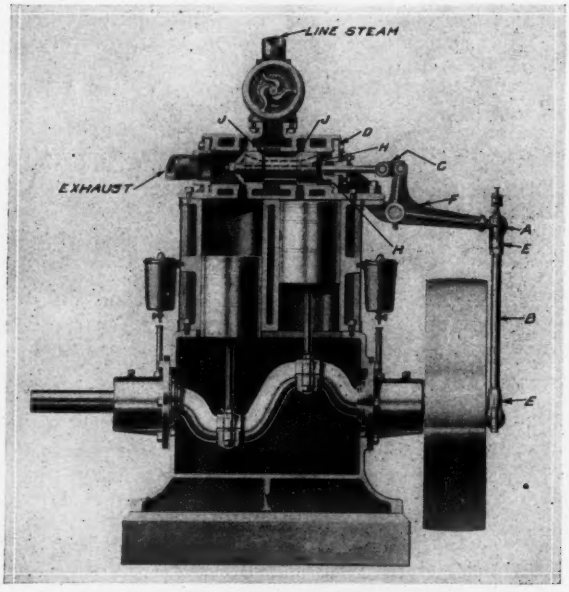
Gas remaining in the bell of the gasometer i, after each registration is drawn off at the same time, since the movements of liquid in the system of tubes n, n', n'', and v are the same as in the system u, e, e' and f.

EMERGENCY ENGINE REPAIR

Broken Rod Causes Shut-Down and Repair Changes Valve Setting

By John E. Kimsley

We have a 9 by 9 Westinghouse Junior engine driving a 25-kw. generator to light the shop and as long as it was doing that I did not bother much with it. If any one had asked me how to set the valve I could not have told how to do it. Our chief went on his vacation and when he was going he gave me an address and told me if anything occurred or I needed advice to telephone him at the company's expense. I thanked him and thought to myself I guess I can run this all by my lonesome for a couple of weeks.



VALVE GEAR OF WESTINGHOUSE ENGINE

While the lights were on and I was taking care of a hot box on the line shaft the bolts that hold the ball and socket joint together at A came out and before the engine came to a stop the governor rod B was broken in 3 or 4 pieces by striking the floor. I chased around and found another rod in the supply room and without taking any measurements, put the ends E on the new rod, hitched it up and got the engine running all in about half an hour. I was just patting myself on the back and thinking what an easy snap the chief had when the peak load came on and down went the voltage. We never had any trouble carrying an overload before and everything looked as it did before the rod broke but the engine would not carry the load so I cut out about 80 of 240 amperes

we were carrying and had about 120 volts with all the resistance out when I should have had 125 volts with the rheostat at about a quarter turn. I gave up and then went to the phone and called the chief who was then in bed and told him just what had occurred and what I had done. He asked me if the new rod was the same length into the boxes as the old one; also if I was sure I was not trying to carry about 30 kw. with one side of a 9 by 9 engine. Then he said: "Now listen careful and write down what I am going to say and if you can't set the valve after reading what you write down, then you had better hitch on to the town lighting system until I finish my vacation and when I get back I will take what it cost out of your pay and find you a job in the shop as you will never make an engineer."

"With the governor on the stop and measuring from the end of link C to end of valve chamber D you'll get the following. At 6½ in. the governor side steam port and the opposite exhaust port are wide open. At 3 in. the opposite takes place, at 4 in. with the lever F moving up the steam valve on the side opposite the governor is just cracked. At 5¼ in. with lever F going down, the steam valve on the governor side is just cracked. This is with the lost motion taken up in the direction of travel and assuming the valve has not slipped on the rod."

I manipulated rod B till I got his measurements between link and valve chamber. Then I took off the crank case plate and put one crank on top, removed the relief valve and found the steam edge of the valve for that side just moving away from the inside edge of port about 1/64 in. I turned it in the direction of travel until the crank on the other side was on top and found the steam edge on that side was just a hair further away from the inside edge of port so I put everything back on and started her up cut in about 250 amperes and the voltage remained up to 127 with the resistance half in. When the chief got back he came in and told me what a good time he had but never a word about the Westinghouse. Now I have made center punch marks on rod and ends and if anything comes loose I can put it back with the dividers.

HEATING AND VENTILATING LARGE BUILDINGS

Outline of Systems to Use Live and Exhaust Steam and of Methods for Combining Ventilation with Heating

By Charles L. Hubbard

ARTICLES IN THIS SERIES of which this is the first, have been prepared especially for those in charge of the mechanical plants of large buildings, such as hotels, office buildings, and public institutions. The present series will be devoted particularly to the heating and ventilating equipment, and will take up the subject under 3 general headings, which may be called "description," "design" and "management."

It is perfectly natural for an engineer to feel that the power plant is of rather more importance than the heating plant, and that the equipment is made up of higher grade machinery, therefore, requiring a higher grade of skill to operate it. In a way, the engineer of a heating plant is regarded as a janitor by the power plant engineer, and when the 2 systems are combined the engineer may retain something of the same feeling toward the heating equipment.

While it is true that engines and generators are much more complicated and interesting from a mechanical standpoint than fans and radiators, heat and fresh air are as important to the occupants of the building as light and elevator service.

It should be the endeavor of every engineer to operate the heating and ventilating system under his charge so as to obtain the very highest efficiency from it in every way possible; and, furthermore, he should understand the principles of design to such an extent that he may intelligently superintend such changes and additions as experience may show necessary to obtain the best results.

In laying out a plant, the heating engineer must, of course, make certain general assumptions and design his equipment with reference to that found satisfactory in similar buildings. As a matter of fact, every large building is likely to develop certain peculiarities of its own, so far as heating and ventilation are concerned, and there is nobody better situated to detect and remedy these defects than the engineer in charge, provided he understands general principles upon which a system of this kind depends.

In treating the subjects of heating and ventilation, a brief outline of the different systems in use will be given, after which some of the more important details of design will be considered, followed by a hint and general instruction upon the care and management of plants of this kind.

Types of Systems

TO a considerable extent, the type of system will depend upon the kind of building. For example, an office building is commonly heated by direct radiation, which may be supplied either with steam or hot water; furthermore, the steam may be either live or exhaust, or a mixture of the two, and may circulate at a pressure either above or below that of the atmosphere. The first of these is commonly called low-pressure heating, and the latter, vacuum heating.

Hot water may circulate through the system by gravity, due to temperature difference between the supply and return risers, or it may be forced through by means of a pump, which is the common method at the present time in all large buildings. The water may be heated in a specially constructed boiler by means of direct contact with the fire surfaces, or live or exhaust steam may be employed for this purpose in connection with feed-water heaters.

Indirect Heating

IN banking rooms, stores, etc., where direct radiators are objectionable on account of their appearance, indirect heating is commonly resorted to. In this system of heating the radiation is placed at some convenient point below the room to be heated, usually in the basement, and connected with the rooms above by means of flues and registers. Air is made to pass over the heaters either by means of a fan or by gravity

and is the medium for conveying the heat to the rooms above. Another form of heating sometimes used in rooms of this kind is concealed radiators, which are placed in recesses in the walls or beneath counters or stairways, and covered with grilles or panels. Openings should be provided at top and bottom in order to furnish a free circulation of air over the heating surface.

Indirect heating is combined with ventilation when the air supply is taken from out of doors, while concealed radiators furnish heat only, as the air passing over them is taken from the room and is simply circulated over and over again.

Ventilation

ORDINARILY, ventilation is only provided in certain parts of office buildings, such as banking rooms and special suites of offices, although some of the latest to be erected have been provided with some general ventilation for the building as a whole.

The great obstacle to the complete ventilation of buildings of this kind is their height and the large number of rooms, which seriously complicates the system of ducts and flues. The general method of air distribution employed is to utilize the upper part of the corridors by means of false ceilings, thus forming ducts from 18 to 24 inches in depth from which registers may connect with the different rooms.

These corridor air-ways receive their supply from the fans through large vertical shafts extending from the basement to the top of the building in structures of medium height. In tall buildings, the sizes of the vertical flues may be reduced by placing fans and heaters both in the basement and on the roof, each set taking care of half the building. When a fan is used, the air can be forced downward as well as upward, so that sometimes the entire ventilating apparatus is placed upon the roof to save space in the basement which is required for other purposes.

Tempering the Air

WHEN a fan supplies air to several rooms it is not usual to combine the heating and ventilation, on account of the difficulty of regulating the temperature in the different rooms. In the corridor distribution arrangement described, it is customary to heat the rooms by direct radiation and supply the air at a temperature of 68 to 70 deg. simply for ventilation. In the case of large banking rooms where all of the air goes to a single room, it may be heated to a temperature sufficiently high to warm the room as well as ventilate it. This does away with all direct radiators and simplifies the apparatus by combining all the radiation required for both heating and ventilation in a single stack.

When a number of small offices are to be ventilated in addition to the main banking room, they may be warmed by direct radiation, while indirect stacks are placed in the ducts leading to the large room.

The air is then heated to a temperature of 70 deg. at the fan and delivered to the small rooms at this temperature, while the supply to the large room passes through the secondary heaters, above mentioned, and its temperature raised sufficiently to warm the room also.

Of the systems of heating which may be used in office building work, that most commonly employed is direct steam, either above or below atmospheric pressure, and hot water under forced circulation is the next.

Exhaust steam from the engines is utilized, so far as it goes, in both steam and hot-water heating, being supplemented with live steam at a reduced pressure when necessary.

Hot water is seldom heated in boilers in office buildings as it is more convenient to supplement the heat furnished by the exhaust by means of a live steam heater.

In some cases, however, where the power plant is small compared with the heating requirements, or where the current for lighting and power is purchased from a local company, it simplifies the equipment to heat the water directly in boilers rather than by steam.

Heating and ventilating requirements of a large hotel are similar to those of an office building. The rooms are usually heated by direct radiation and ventilation provided only in certain rooms such as dining rooms, smoking room, office, etc.

In other buildings the arrangements will depend largely upon their uses and will vary according to local conditions.

In the following articles methods of improvement in existing systems, where possible, and to methods of operation, will be considered as well as the principles of original design.

QUERIES FOR THE ENGINEER

WHAT is the efficiency of your boiler furnace?

What draft will carry your load and burn the least coal?

How much air is leaking through the settings?

Are you admitting more air than is necessary at the furnace, either above or below the fire?

How much excess air from all sources are you heating and sending up the chimney?

Is the smoke you are making caused by lack of air, lack of mixture of the admitted air with the combustible gases or lack of temperature at any point in the combustion area?

Are you using the coal best adapted to your conditions?

Is the fuel bed too thick or too thin?

Are you using the grate best adapted to your conditions?

Is the low evaporation due to the boiler, the furnace, the coal or the fireman?

Is the fireman in your absence obeying instructions as to the method of operation?

How much steam is lost by poor pipe covering?

What is the efficiency of your engines?

What is the efficiency of your generators?

Is your lighting system economical?

Is your power distributed to best advantage?

Are you hiring unnecessary labor?—S. H. Brooks, in the National Builder.

AN ARTICLE IN COSMOS STATES that 2 German chemists, Liebreich and Spitzer, have been conducting some experiments with regard to the protection afforded to iron against rusting by a coat of paint. They come to the conclusion, which is somewhat surprising at first sight, that better results are obtained by the application of a single coat than by painting with 2 or more coats. The explanation which they offer for this somewhat remarkable observation, is that a single coat is more elastic and less liable to scaling off or cracking than a double coat, and thus affords more perfect protection from atmospheric influences.

THE PANAMA CANAL

Details of Chain Fenders for Protection of the Locks

By A. P. Connor

FOR protecting the lock gates of a canal, a feature of great importance yet which is not often seen, is the fender chain, as it is called, which serves to act as a barrier for preventing a ship from damaging the Panama Canal lock gates through its not being stopped in time. This chain extends transversely across the locks, has links 3¼ in. thick, 21⅜ in. long and 11¼ in. outside width and extends through slots in the lock walls into a machinery room, where it passes over suitable sheaves and connects to a plunger which is forced into a hydraulic cylinder when the chain is pulled out in the locks.

Chains are lowered when a ship is to be permitted to pass from one lock to another, and then raised again by means of the hydraulic cylinders in each wall of the lock. If a ship runs into the chain, the chain is paid out at each end with a suitable amount of resistance, obtained by throttling the discharge of the liquid from the main cylinders. This emergency operation is automatic, but for the regular operation of passing boats the chain machinery must be lowered and raised by the operator in the control house. Both ends are similar, differing only as right and left hand. Both ends are controlled simultaneously, but independently of each other.

The main cylinder is fixed or stationary, but its plunger reciprocates within it. The plunger is the moving part and comprises an intermediate cylinder which slides upon a fixed plunger, so that the system is double-acting. The method of operating is as follows: The intermediate cylinder carrying the sheaves when pulled upon by the chain, moves into the main cylinder and forces the water therefrom. The water passes through a pipe closed by a 4-way valve in one branch, and 2 emergency high resistance valves in parallel in another branch. The high resistance valves open under the pressure and permit the water from the cylinder to escape into a tank provided for the purpose. The resistance these valves offer gives a pressure of 750 lb. against the plunger and will stop a 20,000-ton ship going 3 miles an hour in 100 ft., which is the distance that the normal position of the chain is from the gates.

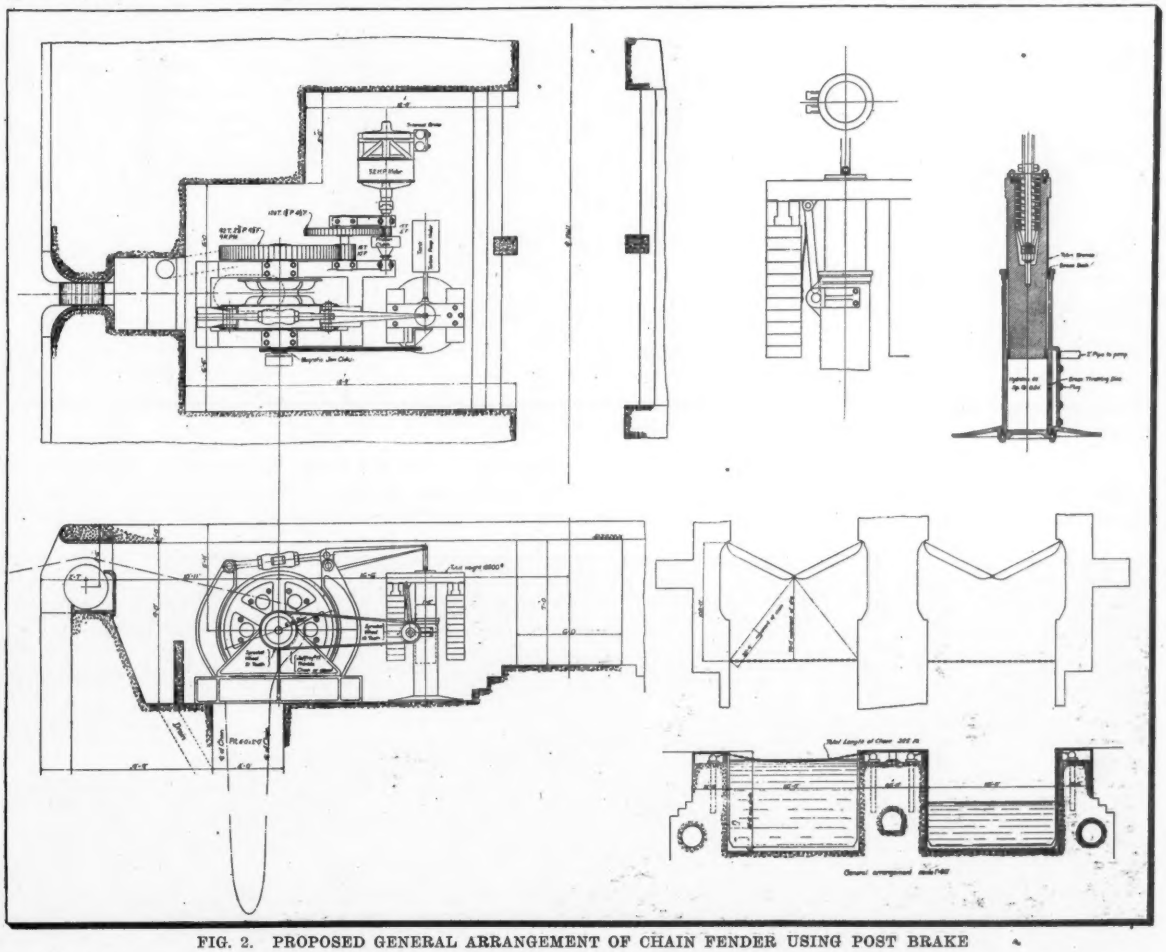


FIG. 2. PROPOSED GENERAL ARRANGEMENT OF CHAIN FENDER USING POST BRAKE

Operations of raising and lowering the chain are as follows: starting with the chain up and taut, to lower it, the 4-way operating valve is thrown so as to permit the water from the main cylinder to flow into the cetrifugal pump and be forced therefrom through the check valves, and the stationary plunger in to the intermediate cylinder. This will cause the

cylinder to raise, and lower the chain to the bottom of the lock. A limit switch stops the pumps when the limit of travel is reached. To raise the chain the simultaneously and both will be controlled from the control house. The limit switch is geared to the moving cylinder so as to stop the pump when the

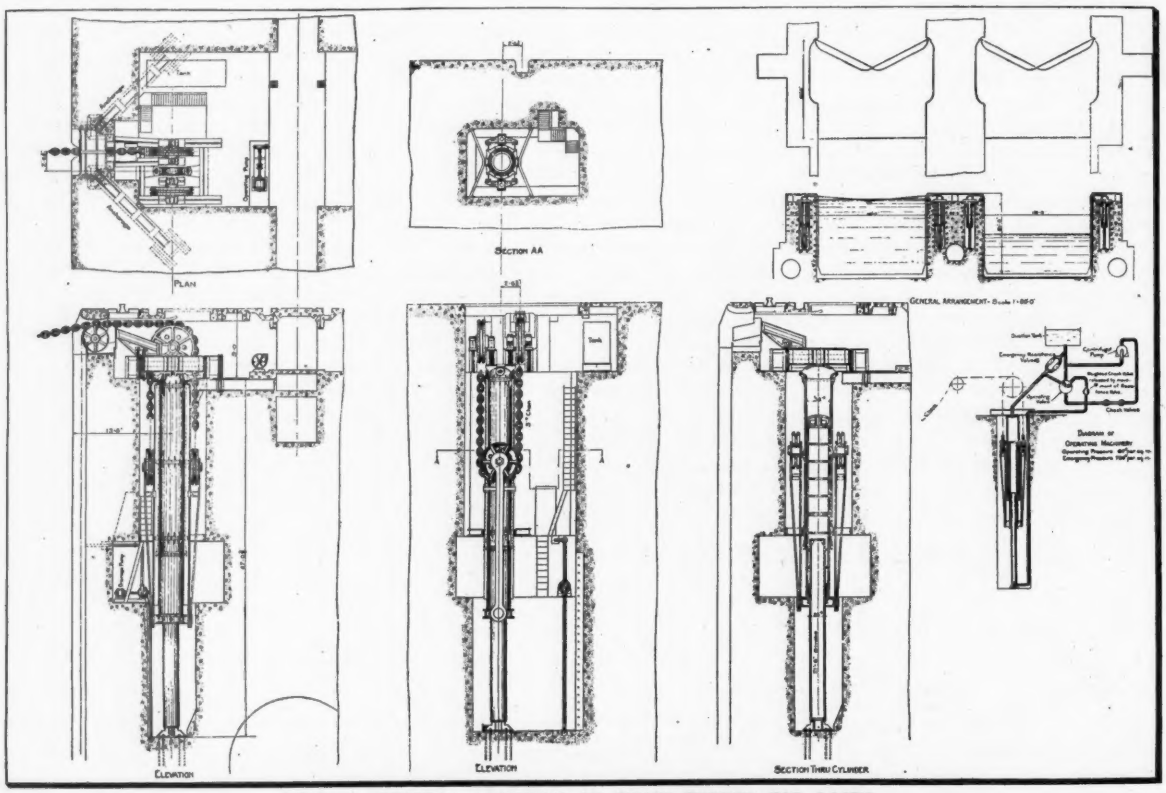


FIG. 1. GENERAL ASSEMBLY OF CHAIN FENDER FOR LOCKS

4-way valve is moved to a second position which permits the pump to raise the water from the lower or intermediate cylinder into the main cylinder. This proper point in the travel is reached. The valve will be maintained in its corresponding position as long as it is desired to keep the chain up. If leakage

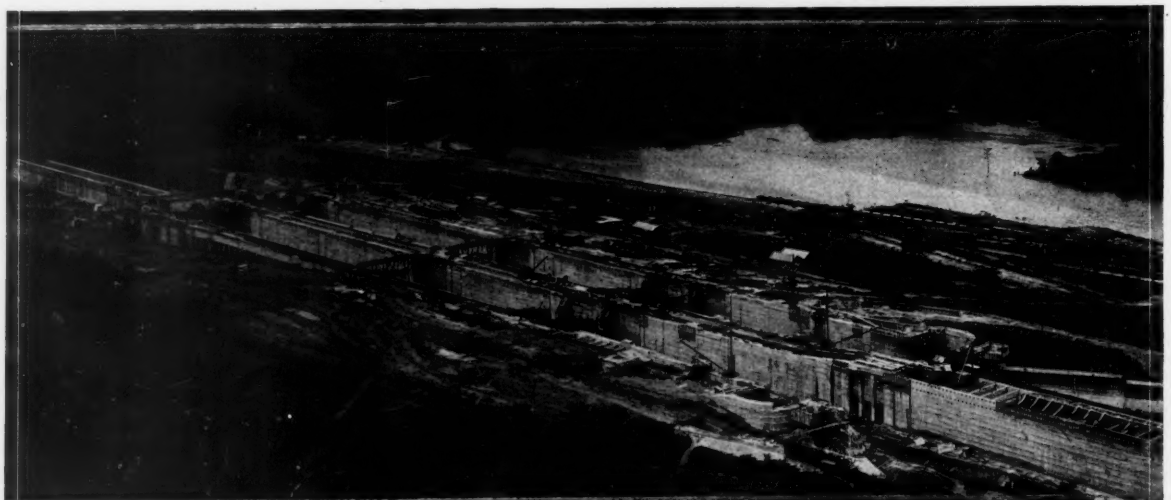


FIG. 3. PEDRO MIGUEL LOCKS, BIRDSEYE VIEW FROM HILL ON EAST BANK

forces the intermediate cylinder downwardly and causes it to raise the fender chain across the lock.

The operating valve and pump are to be started occurs, the tension of the chain may be sufficient to raise the cylinder. The limit switch will then restore the circuit which starts the pump and the chain will

be automatically drawn taut again; also, when the chain is down and the cylinder is up, leakage will permit the cylinder to descend because of the weight of the latter, and the pump will be restarted to raise the cylinder again. It will be noted from the diagram, Fig. 1, that the 4-way valve is arranged to permit the pump to be rotated in the same direction, when the chain is being raised or lowered.

The stroke of the intermediate cylinders on both sides will be 21 ft. 6 in. The length of the main cylinder is approximately 10 ft., and its inside diameter 40 in. The intermediate is approximately 25 ft. long and the total length of the whole device about 47 ft. Another feature used in connection with the fender chain is an interlock which prevents the chain from being lowered before the lock gates are opened. This device consists in an arrangement which locks the switches to be controlled so that they can not be operated before the right time. There are several other details in the construction which serve to provide for special conditions, as for example, a pump is provided for keeping water out of the chamber in which the machinery is located and special frameworks have been designed to support the structure, so that every condition that may be expected has been provided for.

SYSTEM OF AMMONIA COMPRESSOR LUBRICATION

By C. E. Anderson

ACCOMPANYING sketches illustrate a system of ammonia compressor lubrication that I recently installed on an upright 2-cylinder Boyle ice machine. This system of lubrication and the lubricator itself have given entire satisfaction since its installation. It is quite simple and can be installed by any engineer handy at pipe fitting.

A is an oil tank made from a piece of 12-in. pipe, 5 ft. long with caps on both ends and fitted with gage glass and valves as shown in sketch. This tank is placed about 4 or 5 ft. above the top of the compressor so as to insure a gravity flow of oil to the lubricator and stuffing boxes.

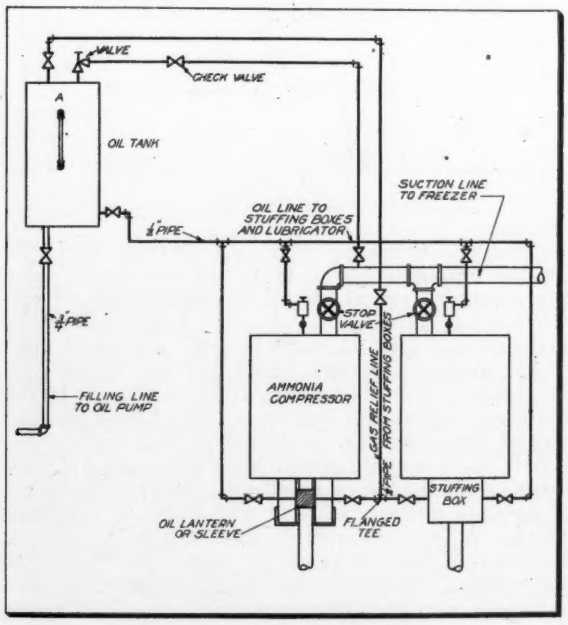


FIG. 1. DIAGRAM OF OIL PIPING

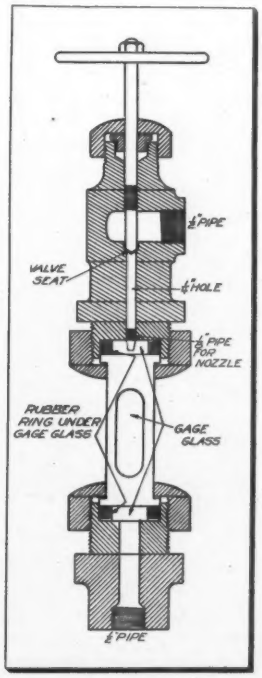


FIG. 2. DETAIL OF SIGHT-FEED LUBRICATOR

The sight-feed lubricator on top of the compressors is made of steel throughout in order to resist the corrosive action of ammonia. The lubricator is tapped into the suction valve chambers on the top head of the ammonia compressors with a valve between the suction valve chamber and the lubricator, also a valve between the lubricator and the oil tank. By closing these 2 valves the lubricator can be disconnected, with the compressor running, for cleaning or repairs as the case may be.

When installing this system one must not neglect to provide a gas or pressure relief line from the top of the oil tank to the suction line of the compressor with stop valves at both ends and a check valve between, as shown in sketch, so that valves can be closed and check valve removed to be reground or repaired without shutting down the compressor and pumping out.

In starting up with this system of lubrication, be sure that the oil gland or lantern in the stuffing box is in its proper place which is opposite the gas relief and oil lines running to the stuffing box so that the

gas collected in the stuffing box can readily pass into the relief line and the oil enter into the gland to lubricate the rod and packing.

The sight-feed lubricator can be adjusted to almost any feed but about 1 drop of oil a stroke gives ample lubrication for a compressor of about 10-in. diameter and 36-in. stroke.

Use nothing but best paraffine oil which will repay its extra cost in the superior manner that it lubricates the cylinder and separates from the ammonia gas in the oil traps. Another virtue of this oil is, if your rod should get cold this oil will not tear the packing out of the stuffing box, due to freezing to the rod. This item alone will repay the extra cost of the oil, as repacking a stuffing box means time lost and also the cost of packing.

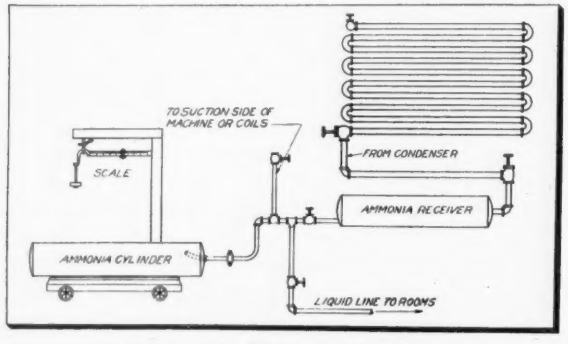
DRAWING AMMONIA

How to Remove the Ammonia Charge from a Compression Plant

By Martin J. McGerry

IN order to withdraw a charge of ammonia from a compression system, connections are made as shown in the accompanying diagram. An empty ammonia drum is connected to the charging valve with a tee in the pipe between the charging valve and the drum. From the branch of the tee a pipe is run to some connection on the suction side of the machine, with a valve in this line if possible. The curved pipe inside the ammonia drum should be turned pointing upward, as shown in the sketch, the empty drum resting on a platform scale. When all connections are made, open the drum valve and the charging valve, allowing the liquid to flow from the receiver to the drum, and watch the scale beam. It will soon be seen that the ammonia stops flowing, which is because the gas forming in the upper part of the empty drum has equalized the pressure.

Shut off the charging valve, and open the valve in the branch line to the suction for a moment only, allowing the gas to pass off. Then close this valve



METHOD OF DRAWING AMMONIA

in the branch from the suction, and open the charging valve, when the liquid will again start flowing into the drum. These operations should be repeated as often as the flow of liquid stops, but do not put more ammonia into the drum than it contained when new.

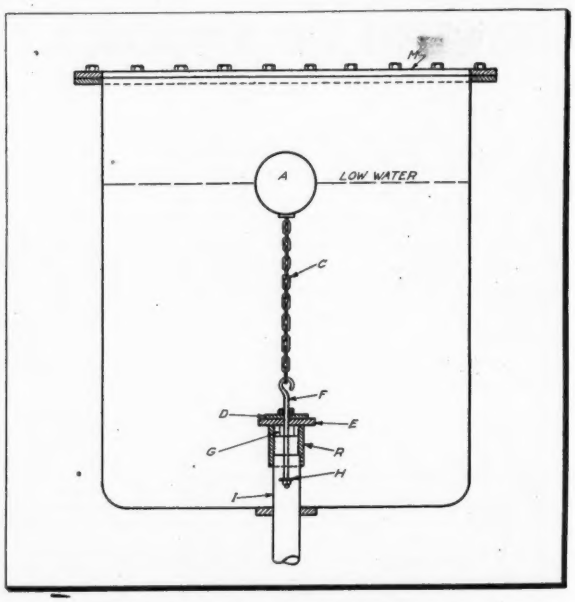
If not convenient to make connection to the suction side of the system, the gas can be allowed to escape to the air, as the amount lost will not be very great. By this process the system can be entirely emptied.

FLOAT VALVE FOR FORE-COOLER TANK

Scheme to Prevent Low Water in Fore-Cooler

By G. A. Robertson

A GREAT deal of trouble and white ice is brought about, by the tank man pulling the water low in the fore-cooler tank. It sometimes happens that the puller will endeavor to get out his pull as quickly as possible, in an effort to get through early and take it easy for the remainder of the day. This is especially true with the night men, who figure that they can get a little sleep when the engineer's back is turned.



FLOAT VALVE IN FORE-COOLER

The accompanying sketch illustrates a float valve located on the inside of tank. In the sketch, which represents a vertical section through center of tank, the cooling coils are not shown. A is a copper ball float, about 10 in. in diameter. C is a small chain. D is a pump valve plate, and E is a soft rubber pump valve about 4 in. in diameter. F is the stem holding plate and valve with lock nuts. Washer H on lower end of stem prevents stem from pulling out of 1½-in. nipple I, by engaging with face bushing G in coupling R, when tank is filled with water. The sketch shows the position of float and valve at low water mark. When the cover M has been bolted in place the valve cannot be tampered with. Just before the valve seats, it makes a very perceptible rattling noise, which is a good reminder that the water is getting low.

AN EXCHANGE GIVES this suggestion for keeping line shafting clean and free from dust. Several large rings are made out of belting, leatherboard, or some such substance, with a hole about twice the diameter of the shaft, and the outside diameter about 2 in. larger than the inside diameter. The ring is cut diagonal on one side, put on the shaft, after which the ends are sewn together with fine wire. The ring travels from one hanger to the other so long as the shaft revolves, and will keep the shaft free of dirt.

CORRESPONDENCE OF AN OLD ENGINEER AND HIS SON*

I HAVE noticed in my days that fully 90 per cent of the injuries happen through carelessness and most of them, especially among the young men like you, are caused by a tendency to "be smart." That reminds me of a smarty who worked in the machine shop where I ran an engine back in 1856, no, '57 I guess it was.

His name was Joe Dangster and there wasn't a thing that happened around the shop from the ash pit to the top of the old stone chimney, but what he could tell you all about it right off the reel.

They had just bought a new-fangled machine of some kind and almost the first thing, the lad who operated it got his thumb in some place just in time to get it cut off. Of course, a number gathered around as they will, among them being Joe, who fairly oozed information in every direction.

"How did it happen?" some one asked coming up in quest of reliable information.

"Why," said Joe, a willing demonstrator, "the darned fool stuck his thumb in there," and he pointed out the exact hole with his finger—when it too was amputated.

Whatever you do, do not cultivate the bad habit of being a "smart Aleck." There is nothing so disgusting as to hear somebody continually telling how smart he is, what wages he has made, the years he worked for this one, and for that one, till he ought to be in the Centenarian class.

In every gang, no matter how small, some one is bound to tell of the astounding stunts that he has pulled off, usually when the official timekeeper was on a vacation. They tell these stories so often that they get to believe them themselves, and the narrative becomes so distorted with the passage of time that when it becomes indelibly impressed on the narrator's mind, it has become ludicrous.

I have heard old Jimmy Duffy tell many a time that he has frequently, in the "old days" reached through the spokes of the flywheel when in operation, and grabbed the oil can off the stand on the other side. And old Hank Bidford looked up from hoeing his cabbages on 4th of July morning to find a deer stuck in the snowbank and which he killed with the hoe. In fact he killed a deer this way every time he went up to Sussex after the mail,—if any one would listen to him.

No, Donny boy, it doesn't pay to brag. Real ability will win in the long run, and even in a short run, will make a far better showing than conceit. There is a maxim that was old when I was a boy and I often hear it now, and that is, "Self praise goes but a little ways."

Now, this does not mean necessarily, that one should crawl into a hole, and pull the hole in after him. You know, this is the day of difference of opinion, and it is this difference of opinion that makes the world go round, otherwise we would all be using one engine, to the exclusion of all other makes, or, all live in houses of the same design, and the world would be one monotonous waste.

Therefore, it is a commendable fact that we should have different opinions on the same subject, and different methods and ideas of doing the same thing. BUT,—when you feel that you have an idea in regard to how a certain job should be done and go to the boss and tell him so, you can express yourself in a plain but forceful manner entirely devoid of any suggestion of self-consciousness or,—to use the expression, —of the "big-head."

Now it is not always possible for the boss to cover the details when giving you a job to do. Usually, in a general way, he gives you a synopsis of the job and what the final result is to be,—but you must work the proposition out yourself.

Take a plain job of pipe-fitting for instance: The "old man" tells you to connect 2 openings in a certain place and run the line over to another place, using valves to accomplish certain things. Now it is up to the man on the job, to do the work and make a "job" of it.

He must determine how to connect so as not to make "pockets," and to allow for expansion, if necessary, where to put the valves, whether globe, gate or angle valves are best, where to make the connection, and whether to use a gasket union or a ground joint union, or a flange or a right-and-left.

It takes brains as well as tools to do any kind of a job. A boss cannot be right alongside of you to tell you HOW to do the work. If he had to, he might as well do the work himself.

Your Chief rose to his present position by being able to do the work himself, and then by being able to tell somebody else how he wanted it done, so that his ideas in a general way could be carried out, and last of all, by being able to pick out the right fellow to carry out his ideas.

The late P. D. Armour said that he didn't make a success of the packing business by being a good packing-house man, but by being able to pick out men who were. It is the same way with everything else. Some men are of a caliber to get just about so high, —a sort of old-fashioned 32-pounder, while other men are of a caliber to move into the brainy class and leave the details to others, who in their turn will be in the brainy class themselves,—if made of the right material.

Donny, boy, don't forget that there is no limit to a young man's possibilities in this world. It depends mostly on himself whether he will climb on up, or always stay at the bottom and thread pipe, twist a throttle, or keep a battery of boilers hot.

This is not saying anything against these jobs. They are all as honorable as that of President of the U. S., for each is a link in the chain that sooner or latter will bind us to success. True, men have made a success in the engineering line, who could not change a die in a stock, or "keep 'er hot," to save their necks, yet if a man starts in when young and does his very best to learn all these things as he goes along, his chances for success are more assured than if he touched only the high spots in passing over the pathway of life.

Well, in reading this far to mother, I find that I have written more than I thought I could. There are many more things that I want to say, but will reserve them till you come home.

Donny, I wrote you when you left college, that there was always a place in the old home for a MacDougal with a backbone in him but that there was no place for one with a yellow streak, or for a "quitter." My son, although you have put a check valve on wrong end to, you have the right stuff in you to make good, and you will be welcomed home with open arms by mother and

Your loving father, Sandy MacDougal.

*Continued from Jan. 15 issue, page 135.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

A PECULIAR MISTAKE

I HEARTILY agree with W. S. in his article in the issue of November 15 that it is not always the operating engineer who makes simple mistakes as it calls to mind an incident that happened to us a short time back.

The plant is a small central station operating 4 small automatic engines exhausting into 1500-kw. low-pressure turbine. This turbine is fitted with a Leblanc condenser with usual circulating and air pumps mounted on the same shaft. Water for condensing purposes is procured from a creek near by and the water contains so much acid from a tin plate mill further up that the pump runners and even the casings last only a short time until they are eaten up and have to be renewed. Now this plant is so heavily loaded that the full load cannot be carried without the turbine so the superintendent devised the plan of having an extra pump complete so when one has to be removed it can be replaced with the other and the old one sent to the shop to be made over. This arrangement saves from 1 to 2 days in making the exchange.

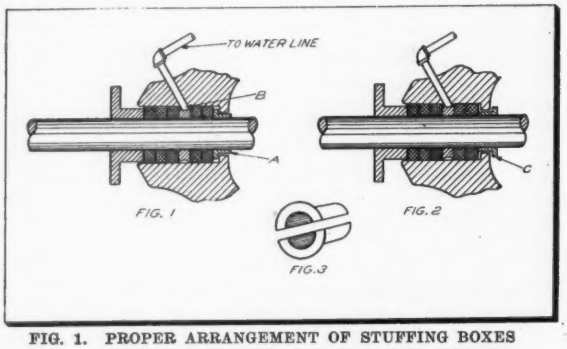


FIG. 1. PROPER ARRANGEMENT OF STUFFING BOXES
FIG. 2. ARRANGEMENT OF PACKING FOUND IN PUMP
FIG. 3. SPLIT PACKING RING USED IN REPAIR

Now as everyone knows who is familiar with this form of pump, the stuffing boxes are arranged as shown in Fig. 1.

There is a small ring in the back as at A Fig. 1, then comes about 2 rings of packing, then a split metal ring made concave on its outer surface with a number of holes running through to the shaft, this ring is supposed to come under the opening from the water line connection as at B, Fig. 1. The box is then filled with packing up to the gland.

A short time back the pump in service at the time failed and was replaced with the other, fresh from the shop, but after the new one had been running for a few days the seal water commenced coming out around the shaft and no amount of tightening up would do any good.

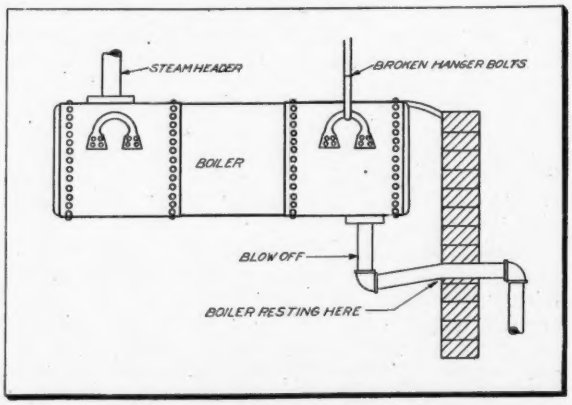
Next day the condenser filled up with water and the pump would not keep it out; finally it got so bad that a stop had to be made to investigate and all that could be found was that the packing was nearly all gone from the water end stuffing box. New packing was put in and a fresh start made, but in a short time is was evident that the pump would not hand its customary amount of water, with the result that the injection water had to be cut down so low that the vacuum would not hold up on heavy loads. We could not haul the load very well without it so it was run in that condition until Sunday, when a stop was made and a thorough investigation revealed the fact that when the pump was assembled in the shop the small ring which should have been placed as at A, Fig. 1, was found to be as at C, Fig. 2, which let ring and packing both go through into the pump admitting enough air to interfere seriously with the action of the pump.

To remove the gland and place it as it belonged would require too much time, so one was removed from the old pump and cut in 2 as shown in Fig. 3. When it was put in and the box packed we found our troubles had vanished.

Now why this ring had ever come to be put in this way is the question; it was evidently a more difficult job than to place it as it belonged as the ring would have had to be held inside the pump and the shaft run through it. E. C. B.

DEFECTIVE HANGER BOLTS AND RESULT

RECENTLY, while inspecting a plant containing 6 66-in. by 16-ft. horizontal return tubular boilers, 4 of which were under steam, I found one boiler with both rear hanger bolts broken or burned off and boiler resting upon blowoff as shown in sketch.



BOILER WITH BROKEN HANGER BOLTS

The blowoff was a 3-in. pipe with malleable ell extra heavy.

Boiler was under 120 lb. of steam and the brick pier around the blowoff had fallen down, leaving pipe exposed to flame of the oil burners.

The boiler had settled 4 in. at the rear, and, the steam header being connected to front of boiler and flanged, one can imagine the strain upon the flange at that point.

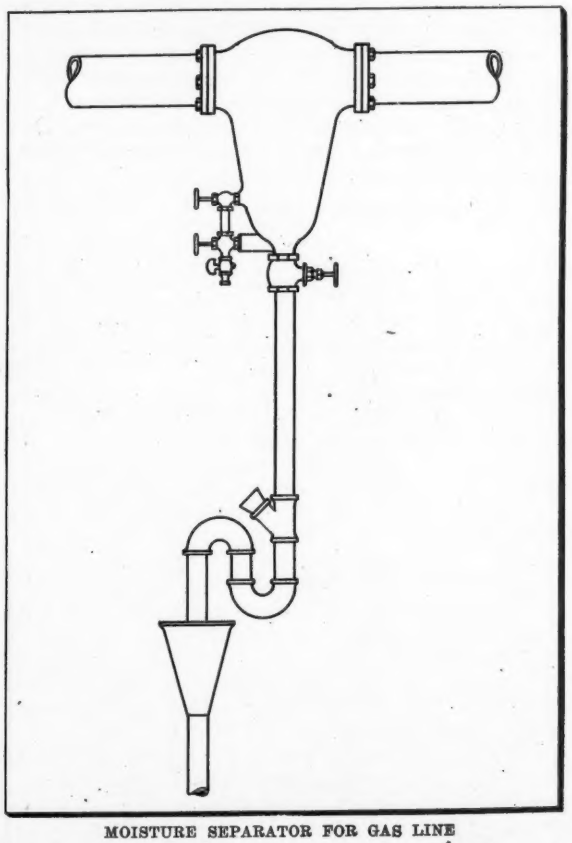
I had the boiler immediately taken out of service and when blowoff was removed the 3-in. pipe extending from ell to wall had a permanent bend of from 6 to 8 deg. C. E. Aldrich.

WATER IN THE GAS

THE gas producer engine referred to here was a 375-kw. machine running at a speed of 150 r.p.m. We were having all sorts of trouble with the engine pre-igniting and the igniters being grounded; which by careful experiments was found to be due to water in the gas.

The gas house is about 500 ft. from the power station and the gas main runs out in the atmosphere about 200 ft. and the remaining distance through the building over hot furnaces.

It was decided that the sudden changes of the temperature caused this condensation.



MOISTURE SEPARATOR FOR GAS LINE

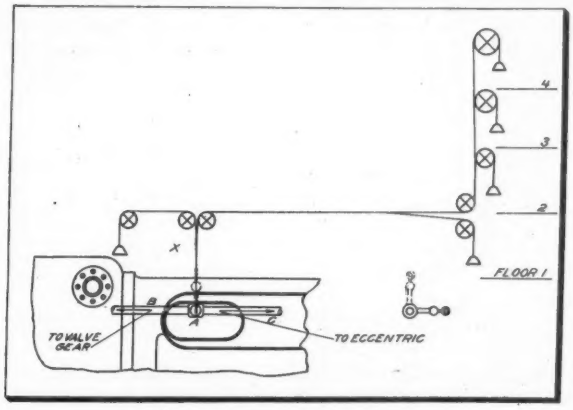
As the company did not want to add any expense by buying a moisture separator, as they were about to change their plant from steam to gas power and with the new equipment there would be all the latest improved devices to take care of the 2000-kw. plant they were about to install.

It was decided to try a steam separator and also to put baffling plates in the gas main next to the separator as shown in the drawing. From this separator a pipe led down with 2 return bends which made a trap and from there it emptied into the sewer. This trap acted as a water seal and held the gas from escaping to the atmosphere.

The engineer in charge was instructed to watch and at any time there wasn't any water coming out, to take out plug at the level of top of return bend and fill the bend up with water till it came out of the overflow. R. S. Mason.

AN ENGINE STOP

ACCOMPANYING drawing is a plan which I had installed in my plant so that in case of accident on any floor in the building or engine or boiler room, the steam can be shut off from the engine much quicker than it would take to get to the engine or close any valve. All that is necesary is to pull the handle which is placed on each floor and in the boiler room and



MEANS FOR STOPPING ENGINE

immediately the clutch A is thrown out as shown at X and the steam valves do not lift to admit steam, the engine immediately slows down and stops with the throttle wide open. It is a Rice & Sargent double-eccentric 4-valve engine. The rod B telescopes in rod C when thrown out, and rod B stands still while rod C moves with eccentric. This works perfectly and can be relied upon. A. C. Waldron.

A RUNAWAY PUMP

FROM time to time we read in the engineering periodicals of runaway engines, but this incident is of a runaway pump, used in elevator service to raise 750,000 to 1,250,000 gal. of water a day into a tank on the roof of the building, for the purpose of operating hydraulic elevators on the gravity system.

Just 9 days before the accident, the chief engineer caused an inspection to be made of all suction and discharge valves, and they were found in good working condition except that one valve spring was found broken and was renewed. The night before the accident the stuffing box of the valve rod was repacked, as the old packing was thought to be hard and the new packing would cause the valve stem to work more freely. About 5 o'clock on the night of the accident, this valve stuck open, causing the pump to race and in consequence the pressure on the water end was increased so that it broke about 75 per cent of the valve springs, putting the pump out of commission, and started the gaskets in cylinder heads and

RETURN TANK WITH IMPROVISED GAGE GLASS

RETURN tank with a makeshift gage glass is shown in the accompanying sketch. Not having a glass of the proper size, which would be 28 in. long and ½ in. thick, I got 2 ordinary ½-in. boiler gage glasses and joined them together with a piece of old ½-in. rubber tubing about ¾ in. long. As there is hardly any pressure on the tank, only the weight of the water, it answered the purpose.

We had a noncondensing engine at the plant, which took some time to start every morning on account of excessive water in the steam line. There was a ¼-in. bleeder in the steam pipe just over the

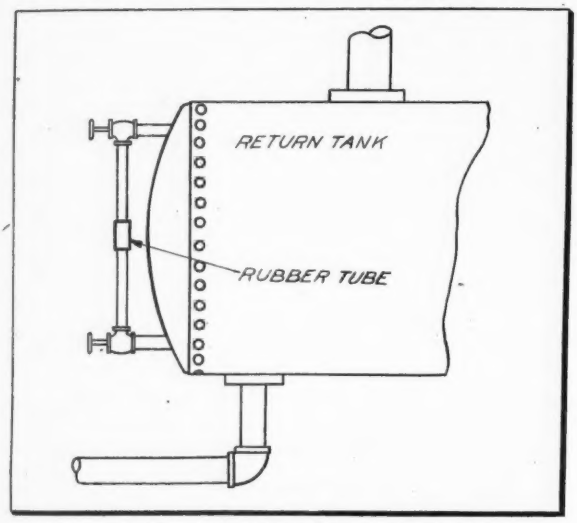


FIG. 1. IMPROVISED GAGE GLASS ON RETURN TANK

throttle. It would take about ½ or ¾ of an hour for the pipe to drain before the engine could be started. The steam line to the engine was an exceptionally long one. I was told to remedy the trouble.

Where the steam line came into the engine room was an expansion made of 2 ells and a short nipple. I replaced the lower ell with a piece of 2½-in. pipe (the steam line being 2½-in.) 2 ft. long, with a cap on the end, a hole being drilled into the cap and tapped for a ½-in. pipe, which was run into a trap, which in turn discharged into the return line running to the return tank. There never was any more trouble with water in starting the engine. G. A.

FIBROUS AND METALLIC PACKINGS

REPLYING to request by Charles J. Mason, page 1190, Dec. 1 issue, for our experience and opinion in the matter of packings, I would state that on our 20.25 by 48-in. Corliss engine I use metallic packing for the piston rod stuffing box. The rod, when installed 8 yr. ago, after boring out the engine, was 3 3/16 in. in diameter and it is 3 3/16 in. in diameter today. The engine has been in service 6 days each week of the 8 yr. The rod is a beautiful dark brown color, and has as glossy and smooth a polish as one could wish. To pack this stuffing box with metallic packing costs $2.50, and it has been renewed once in 3 yr.

On the valve stems of the same engine, which is a much easier place on packing, we use fibrous packing. The steam valve on the head end of the engine is packed with the same packing that I placed there 4 yr. ago last July, and it is holding in fine shape yet. While I have packed the other 3 valves 3 times in the 4 yr. 5 months, this does not include the first packing in July. The same kind of packing was used on all the valves, all taken out of same box, and most of it off the same coil of packing. Valve stems are all in good condition.

The stuffing box of our air compressor is packed with a grade of packing much inferior to that used on the engine valves and it has been in service close to 5 yr. without renewal. And now, summing up, it is evident that the life and efficiency of a packing depend as much upon the conditions it is to meet as they do upon the constitutional qualities of the packing. In buying packing we always select that which comes the nearest to meeting the following requirements of fibrous packing: It must be such that it will not shrink, cringe or buckle under the action of heat. It must be such that the action of heat will not destroy the cohesion or union which holds the atoms (of which the packing is made) together. Its nature under the conditions under which it is to be used must be such that it is nearer a lubricant than an abrasive. It must be such that it will not swell or otherwise metamorphose itself under the action of moisture and heat of themselves, or when operating in conjunction with the innate or any acquired characteristics or constitutional qualities it may have. It must be such that it will not honeycomb or become porous under the action of heat. It must be as soft and pliable after a reasonable baking as it was before baking.

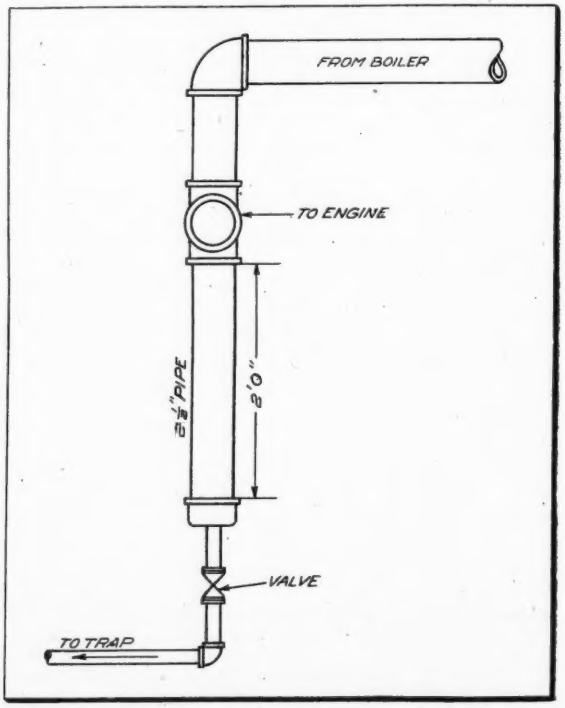


FIG. 2. METHOD OF DRAINING STEAM PIPE

Select a packing that comes the nearest to meeting these requirements and you have the best fibrous packing that can be had. Then see to it that it is the proper size for the place where it is to be used. Cut the ring and break all joints in the right way and you will have little trouble with the packing scoring the rod or leaking. I never allow steam to blow from a joint that I

pack. I pack it right and then pull up on the gland bolts reasonably hard with a wrench, and if it leaks when steam or water is turned on I pull it up until it stops blowing. The theory about letting it blow awhile rather than pull upon the bolts right away and stop it, is all wrong.

I think that the best way to know whether fibrous or metallic packing is the better for a given machine is to try them both and watch results. I must say that I get good service out of both kinds.

Thos. C. Robinson.

LAYING OUT IRREGULAR SURFACES

AS engineers are frequently called upon to do some sheet-metal work such as putting up or replacing air ducts, the following methods of laying out a frustum of a cone or funnel and also an elbow, may be of interest to some readers as no formulae and no other dimensions than the diameter and length of the pieces to be made are required. Fig. 1 shows the plan and elevation of a 3-piece elbow and a collar. The developments of section A and also of section C when the joint is the same angle are shown in Fig. 2. Fig. 3 is the development of section B and Fig. 4 is the development of the collar D.

In order to construct the various parts that make up the pipe it is necessary to know what size and shape to mark out on the sheet, so that when cut out and rolled up the pieces will form cylinders with the ends fitting together as required. First draw a plan and elevation (Fig. 1), either full size or to any convenient scale.

To develop the section A divide the circle on the plan that represents the base of the section, into equal parts, say 12, as shown, 1-12. From these points draw light lines parallel with the center line, to the oblique line that divides A and B. As the section A is unfolded beginning at point 1 the successive elements 1-12-11, etc., will appear at equal distances apart in Fig. 2, and equal in length to the lengths of the same elements in the elevation. Thus, point 10 in the development is found by projecting horizontally across from 10 in the elevation. The length of line a-a in Fig. 2 is equal to a-a Fig. 1, etc. The development of any similar surface may be found in the same manner. The horizontal dotted lines need not be drawn but are used here to make the matter clear.

To draw the development, Fig. 2, draw the base line and with compass set to the distance 1-2, etc., in Fig. 1 plan, divide the base line as shown. Draw verticals through each point and on each vertical 1-12-11, etc., lay off with the compass the same length as found on the corresponding element in the elevation. A line drawn through these points gives the shape of the edge, if the angle of the joint between B and C is the same as A B. The same plan can be used but if not the section C is developed in the same manner as section A. In developing section B there is no base line to work from so one is drawn as shown at xy in the elevation the lines 2-12, 3-11, etc., are projected parallel to the center line of the section B. To develop first draw the base line xy, Fig. 3, and lay it off as in drawing section A. Draw verticals through these points. Then with the compass measure the distance from xy to the joint line on Fig. 1 and lay off this length on the corresponding vertical line. A line drawn through these points gives the shape of the section.

So far no allowance has been made for the lap, this will depend on the type of joint, whether soldered or riveted. But all that is necessary is to lay off the required width outside of one of the lines 1, Fig. 2, and also on the intersecting edges of A B and C., i.e., if the lap is to be ½ in., draw a line parallel to and ½ in. from the line A B, Fig. 2, as shown dotted and cut on this line. Proceed the same with sections B and C. In developing the collar, which is the frustrum of a cone, as shown in the elevation Fig. 1 B, draw the base line equal to the required diameter of the collar as shown in the plan Fig. 1, H-I, and on the center line locate the point g above K equal to the desired altitude and then complete the triangle by drawing the lines G I and G H or draw them at any desired angle. Draw the line G-H, Fig. 4, equal to G-H, Fig. 1, and with the compass set to this length, describe the arc H I with G as a center. Divide the circumference of the circle in Fig. 1, that represents the outside diameter of the collar, into 12 equal parts, and with the compass set to this length, step off an equal number of spaces on the arc H-I, Fig. 4. Then draw the line G I. To get the smaller circumference, set

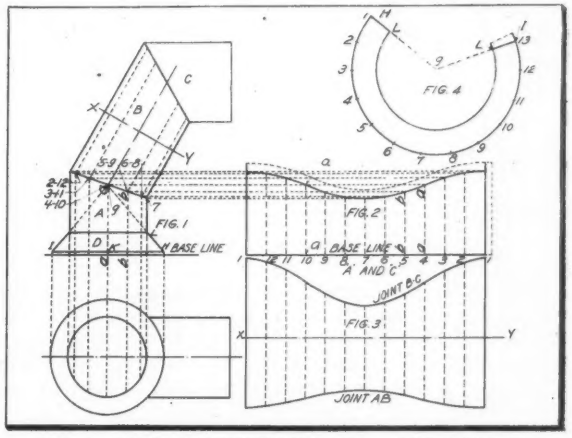


FIG. 1. PLAN AND ELEVATION OF A 3-PIECE ELBOW
FIG. 2. DEVELOPMENT OF SECTION A
FIG. 3. DEVELOPMENT OF SECTION B
FIG. 4. DEVELOPMENT OF COLLAR

compass to the length G L, Fig. 1, and with G as a center describe the arc L L on Fig. 4. To the line I L add the required width of lap.

In laying off the development of a funnel proceed the same as in Fig. 4. Just lay off the distance equal to the diameter and then the altitude or slant height, as the case may be. If the hole of the small end is to be ½ in. in diameter, set the compass to the distance on the slant height from the point of the apex to a point where the distance between the 2 slant lines is ½ in., then allow for the lap on one edge. In the figures shown more lines have been drawn to illustrate the work than are required in the actual work. On a trial it will be found that this method is easy to remember and no formulae or calculations are required and no tools other than a square, pencil and compass.

J. C. Hawkins.

AS SHOWING the value of buying coal on specification and analysis, the saving to the Isthmian Canal Commission by this method under supervision of the Bureau of Mines has resulted in a saving of $75,000 in a year besides insuring delivery of a higher grade of coal than would otherwise have been obtained.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Repair Job on Compound Engine

A SHORT time ago I had a repair job on a 20 by 36 by 48-in. cross compound engine which may be of interest to some of the readers of Practical Engineer. The low-pressure cylinder took water on the head end, forcing the front of the pillow block off, at the same time breaking the cap, as shown in Fig. 1.

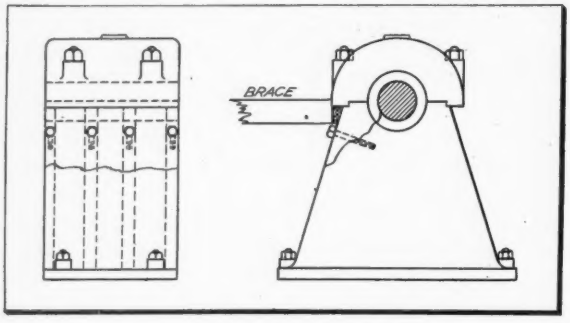


FIG. 1. BROKEN PILLOW BLOCK

The shaft was thrown out of alinement so that the 50-in. main belt ran off the pulley so far that it came in contact with the foundation, ripping the belt open about 3 in. for its entire length. The belt was taken off and repaired. In the meantime we got ready to repair the pillow block so that a part of the plant could be run by the high-pressure side. Four 1¼-in. clearance holes were drilled in the broken piece, after which it was put in place and the pillow block marked. We then drilled 4 tapping holes and fastened the piece in place with 4 ¼-in. tap holes. Two wrought iron straps, 1 by 2½ in., were used in place of the cap. The low-pressure side was then disconnected and the belt, having been repaired, put on. This enabled us to run a part of the plant until a new pillow block arrived.

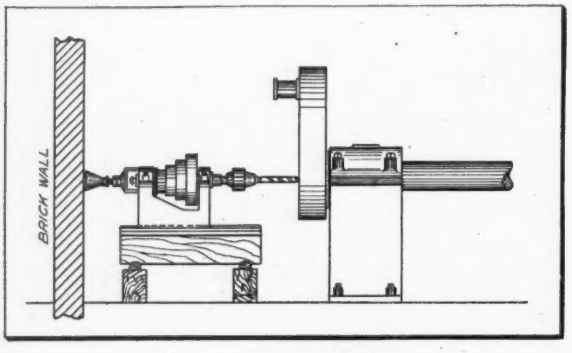


FIG. 2. REMOVING CRANK

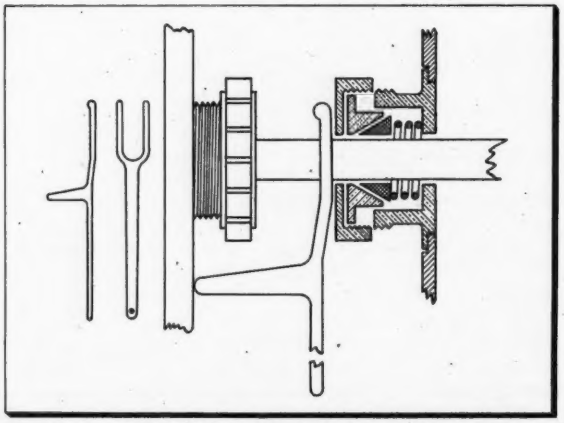
The shock received by the crank sheared the key about 1-16 in. on the shaft and we thought it advisable to have a new crank put on. When the new crank arrived, the engine builders sent a man to do the work, bringing ratchet and drills with him, but before he arrived on the job I had arranged to do it in a different way. I took a headstock from one of the lathes in the machine shop, blocked it up level with the center of the crank shaft and with a drill chuck in place and a jack screw between the wall and the headstock for a feed. We removed the crank in 1½ hr.

Figure 2 shows the method of drilling the crank. A 12-in. face pulley was placed on the shaft of a 6-hp. upright engine and belted to the cone of the headstock, using the small step of the cone to begin with moving up a step as we came nearer the driving engine, so that the belt had to be taken up only twice during the operation after the holes were drilled in the crank, tapered pins were driven into them, which split the crank along the row of holes. The new pillow block was put in place and the new crank heated and shrunk on the shaft, all adjustments made and the job was completed. All preparations were made, such as getting the drilling apparatus, engine and lathe headstock ready, during the day, while the plant was running, so that no time was lost in getting to work after shutting down.

Robert Love.

Fork Wrench for Forcing Packing Nut and Gland Into Place

PISTON rod packing of a great many air and water pumps, as well as that of many other types of compressors is of the cone and spring type. This class of packing is generally of such a construction that the packing material engaging the piston rod is continually forced to it by a powerful spring, which at the same time forces the packing into a conical gland. As a result it is often very difficult to force the stuffing box nut up to the stuffing box itself in order to start the threads on the inside of the nut over those of the stuffing box.



METHOD OF USING FORK WRENCH FOR PLACING NUT AND GLAND

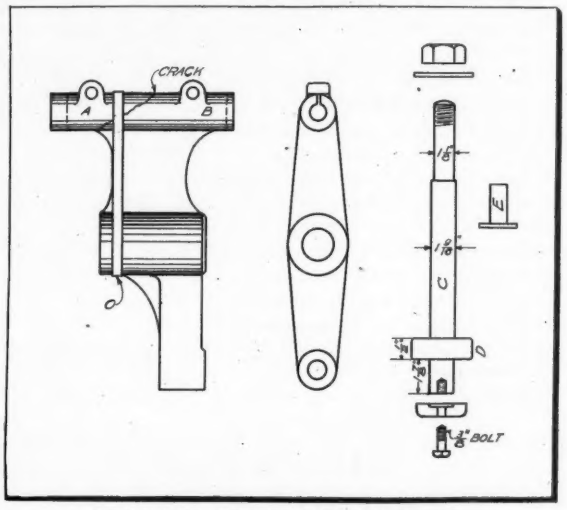
The sketch shows the construction of a simple fork wrench which can be conveniently and readily utilized to force the packing nut up to the stuffing box against a spring of almost any strength.

The tool is very simple in construction, and is of great assistance in packing the rods of any double cylinder pump possessing a strong gland spring.

W. B.

Mending a Rocker Arm

WE met with an accident at the municipal lighting station which I dealt with in the following manner: I first took broken part A, chucked it, turned off bolt boss, and faced off ½ in. I then faced off ¼ in. on opposite end, B. The blacksmith welded the collar D on pin C, which is 1 9-16 in. diameter. I made small end 1⅛ in. and made pin 1-16 in. shorter from collar to shoulder than the casting after being faced so it would draw. I



DETAILS OF CAST-IRON ROCKER REPAIR

bored collar E 1⅛ in. with ¼-in. collar on end. This was followed with a ⅛-in. washer and a thin nut which, when assembled, formed a draw bolt, in place of a straight pin. The blacksmith shrunk band O, ½ by ¾-in. soft steel, on as shown. The job when finished was far stronger than the casting alone. This was a rocker arm for a double cutoff high-speed engine.

E. E. Sarr.

Shop Kinks

ANVILS may easily be fastened to wood block by using 2 short chains fastened to eye bolts. Place the chains around the anvil as shown in Fig. 1 and tighten eye bolts, which in turn are made fast to block as shown in cut, this secures the anvil firmly in place.

Shingling hatchet heads get worn out after long usage and consequently slip off the nail head very easily. This can be easily fixed by drawing the temper and filing the head down a little to make it straight again, then cutting the grooves deeper with a hack saw as shown in Fig. 2. Temper the head and you will find your shingling hatchet to be as good as new.

It at times happens that you find yourself in need of a pipe wrench when none is available. You can convert your monkey wrench into a pipe wrench which will answer the purpose very well. Place monkey wrench on the pipe you desire to turn, screw out, leaving a little space between the jaws and pipe, next place a nail set between pipe and jaws as shown in cut, turn the wrench a little in the direction of the arrow, this will give a rotary motion to the nail set and the middle part of set will grip pipe solidly so that it can thus be turned as

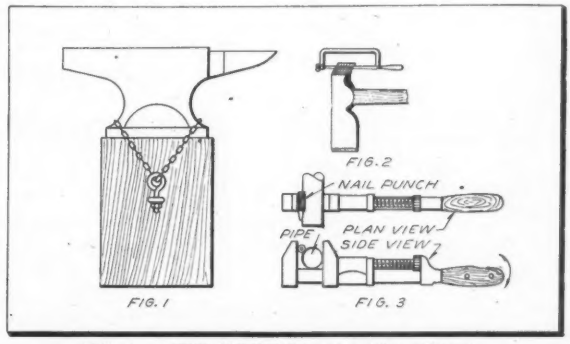


FIG. 1. ANVIL SECURED TO WOOD BLOCK
FIG. 2. REPAIRING A SHINGLING HATCHET
FIG. 3. IMPROVISED PIPE WRENCH

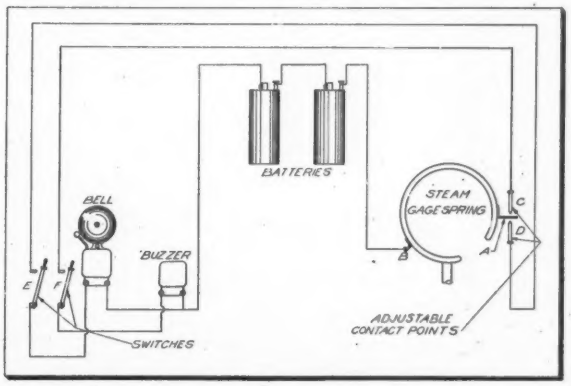
well as with a pipe wrench. Try this some time and you will find yourself more than pleased. A rat tail file can be used in place of nail set, if you so desire.

G. H. Holter.

Steam Pressure Alarm

THE accompanying sketch illustrates a high and low steam alarm which I have in use in my engine room. It is made from an old steam gage spring and connected to the steam pipes at any convenient place; mine is on my gage board.

When the steam rises the spring naturally expands, makes a contact with contact point C and starts the



HIGH AND LOW PRESSURE STEAM ALARM

buzzer and when the steam drops it makes a contact with point D and rings the bell; either one can be thrown out of the circuit by the switches E and F. By using the steam gage spring itself there is no lost motion.

The contact points C and D are made of banjo bracket lugs tapped with a ¼-in. thread and a pointed screw and lock nut so they can be adjusted to any desired pressure; where a man does his own firing, as I do, it helps him quite a lot. W. W. Cary.

GREAT AND POWERFUL men grow out of adversity in some form or other.

We cannot become powerful through ease and freedom from opposition.—Tips.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Boiler Patches

WILL some reader of Practical Engineer please explain the difference between a hard and soft patch?

F. E. K.

A. A hard patch consists of the regulation riveted on patch. A soft patch is attached to the boiler with cap screws and a space of about ¼ in. is left between the patch and the boiler, after which the patch is plastered around with putty or similar material and the space filled with hard babbit metal. The patch is then drawn up while the babbit is warm.

H. G. M.

Massachusetts Examination Questions for First Class License

SHOW by figures the allowable pressure on a 54-in. boiler, sheet thickness 11/32 in., diameter of rivets 13/16 in., pitch 3½ in. and 7 in.

2. Show by figures the allowable pressure on heads of a 60-in. boiler having 12 diagonal stays, height from tubes to shell 24½ in.

3. Figure efficiency of ligament between tube holes on steam drum, diagonal pitch 6 in., longitudinal 5.75 in., diameter of tube holes 4 in.

4. Draw indicator diagrams such as you would expect to get from a cross compound engine running in good condition.

5. Figure hp. of engine 28 by 60 in., 75 r.p.m. single condensing.

6. Draw diagram showing leaky exhaust valve.

7. If your steam valve failed to open on Corliss engine what would you do to make it open and keep running?

8. Describe a siphon condenser, also the jet and surface types.

9. How can you tell if a surface condenser is leaking?

10. If you lost your vacuum on a condensing engine and you got it again and started up all right, then your receiver pressure went down to nothing what would be the trouble and how would you remedy it?

11. How can you tell if an engine with a shaft governor has a variable load or not?

12 and 13. How many cylinders has a Westinghouse engine? What kind of valves has it and how many?

14. How does it take its steam?

15. What kind of valve motion has a single pump?

16. Describe a Sterling boiler.

17. What is the difference between a Babcock & Wilcox and a Heine boiler?

18. If a tube in a B. & W. boiler burst how could you repair it so that you could start and run the boiler again?

19. Why is a butt strap joint stronger than a lap joint?

20. Where would you put a superheater on a return tubular boiler?

21. Would you use superheated steam and how would you do it?

22. Why do you want to use superheated steam?

23. If the temperature was too high how would you reduce it?

24. What is a dry air pump and what is it for?

25. What is the position of steam eccentric in relation to crankpin on low pressure cylinder with 2 eccentrics?

26. With your wristplate central, in steam valve on low pressure cylinder with 2 eccentrics closed?

27. What is the latest point of cutoff on single eccentric Corliss engine?

28. Describe a closed heater. An open heater.

29. How could you tell if a closed heater was leaking while your engine was running?

30. How could you get water into the cylinder of your engine from a closed heater?

31. How from an open heater?

32. If your low-pressure cylinder on a cross compound engine was doing more work than the high-pressure what would you do to equalize the load?

James Reid.

A Criticism

UNDER the above heading in a back issue of Practical Engineer, I find some answers to which I feel compelled to take exception.

1. What would you do if you had steam blow out of your boiler settings?

In this answer it is stated "also the fire should be pulled." If the fire were thin and not very brisk this might be advisable; but in a majority of cases it would be unwise. With a heavy fire it would not only be a difficult task but also it would generate intense heat during the operation, just what should not be done. It is better to kill the fire by covering heavily with wet coal, ashes, or loam. If steam were blowing out the fire doors so as to make either operation impossible, then the ash pit doors could be closed with a hoe and stream of water played through fire doors to aid in cooling off the fire. Some such expedient as this would be necessary in case of some stokers.

5. What is lap for on a Corliss engine?

Here we run against what has been a stumbling block to many an engineer. In my opinion the answer given is entirely wrong and does anything but help the situation. Therefore an answer of some length seems necessary to get things right. When the dashpot plunger bottoms in the dashpot the valve is fully closed. In this position the edge of the valve has overtravelled the edge of the port, let us say ½ in. This overtravel is necessary to prevent steam leaking through during exhaust stroke. But this half inch is by no means the lap of the valve. The lap of that

valve may be ¼ in., ⅛ in., 0, or even a negative quantity. Overtravel and lap are 2 entirely distinct things with very different purposes.

In a Corliss engine with the dashpot plunger way down and the latch hooking on, the eccentric is at full throw and we can't measure lap there. To measure lap on the Corliss engine we must hook up both valves and turn eccentric to mid position; or what is simpler and amounts to the same thing, the wristplate may be set in middle of its travel by marks on the hub and stud. If the engine has no wristplate, then any point on reach rod or eccentric rod may be taken; its limits of travel found; and then placed half-way between these. This then is lap of a Corliss engine, the distance between edge of the valve and edge of port when the valve gear is at middle point of its travel. This lap may be either positive or negative. It bears no relation whatever to the amount of overtravel or overlap when the valve is closed. The same reasoning applies to Green, Brown, and other drop cutoff engines.

6. How could you tell that your piston needed centering without taking off the cylinder head?

Oftentimes a look at the piston rod is enough to settle this question. If the rod is low in the gland, it is probable the piston is also low. I have seen engines running with the rod rubbing on bottom of gland.

11. If while shutting down a compound engine the condenser should stop, what would you do?

Certain conditions, understood well enough locally, force Massachusetts examiners to come at many rather simple things in devious and diverse ways. This is an instance. Probably all the examiner wishes to learn was whether the applicant knew there should be a valve between the low pressure cylinder and the condenser. With this valve shut no harm can come from stopping the condenser.

12. If you had a condensing engine fully loaded and your condenser broke down what could you do to keep running?

If ordinary boiler pressure is not up to limit allowed, it may be that increased pressure will do the trick, though such a condition is improbable; otherwise some load will have to be dropped.

13. If the bursting pressure of a boiler is 750 lb. why do they not run pressure nearly to that in a hydrostatic test?

If steel is stretched beyond the elastic limit it receives a permanent set. The elastic limit of boiler steel is about 50 per cent, so it is evident that if 400 lb. above boiler pressure were used a permanent deformation would take place, and this must not be allowed.

14. In a small vertical boiler 36 in. in diameter or less, how would you stay it if you did not use stay bolts?

The answer to this question states "The firebox of a small vertical boiler is cylindrical in shape, consequently the sides do not require stays or braces." The firebox is cylindrical, but excuse me from being in attendance if that boiler is fired up without bracing the sheet. If the pressure were on the inside of that cylinder, stays would not be necessary. The pressure is upon the inside of the outer sheet of the water leg and this needs nothing to stiffen it. But the inner sheet receives pressure upon the outside of the cylinder, about as precarious condition as we meet with in boiler building. With pressure upon the outside walls of a cylinder any slight deformation is quickly magnified and collapse immediately follows. Therefore any such sheet must be stiffened against possibility of collapse. In larger boilers the inside sheet is stayed to the outer by stay-bolts. In boilers less than 38 in. in diameter, Massachusetts rules allow furnaces of this sort to be either corrugated or stiffened with an Adamson ring or equivalent. (See page 35, paragraph 22, latest edition of rules.)

15. What is a twin air-pump?

This consists of 2 pumps each driven direct by a steam cylinder, both main valves of which are actuated by a single auxiliary value. A beam connects the 2 piston rods, so that one rod moves up as the other moves down. The pumps are single acting while steam cylinders are double acting—the beam allowing both steam pistons to work together upon the one bucket working at any instant. Suction valves are at bottom of the barrel and discharge valves in the bucket. William E. Dixon.

Steam Boiler Questions

PLEASE oblige me by answering the following questions:

1. How can I find the extreme safe working pressure allowable on a boiler of the horizontal tubular type?

2. How is the strength of a riveted joint found as compared with the solid sheet, i. e., a double riveted lap joint having a thickness of sheet of ⅜ in., pitch of rivets 3¼ in., diameter of iron rivets ⅞ in., diameter of rivet holes 15/16 in., tensile strength of metal 60,000 lb. per sq. in. of section, shearing strength of rivets 40,000 lb. per sq. in. of section? Give efficiency of joint.

3. What is the proper connections of the water column and steam gage to boiler?

4. How do you find the capacity of a pump or injector necessary to supply a boiler rated at 100 hp., with sufficient water, the calculation to be based on 30 lb. of water evaporated per hp. per hour?

5. How would you figure the number of braces required to properly support the flat surface above the tubes in a horizontal tubular boiler? Give rule to find area of segment.

6. What pressure is allowed on a boiler flue 18 in. in diameter, 12 ft. long, of 5/16 in. steel, having long seam, single riveted and in 2 sections? Give rule.

7. What pressure is allowed on a Morrison furnace flue 50 in. in diameter, of ⅜ in. material? Give rule.

8. Give dimensions for single and double riveted lap joints, also size of rivets required for the following thicknesses of metal: 3/16 in., 3/8 in. and 7/16 in. Give efficiency of joint.

9. Taking rivets in single shear at 38,000 lb., double shear at 70,300 lb. inch of section, give method of analysis of butt; seam double strapped, having 2 rows of rivets in double shear and one row in double, single, or below. Plate has 60,000 lb. tensile strength, thickness ⅜ in., thickness of straps 5/16 in., diameter of rivet hole 13/16 in., single pitch 3¼ in., double pitch 6½ in. Give efficiency of joint. W. G.

A. The working pressure allowable on the shell of a horizontal tubular boiler is determined by the formula: $\frac{S \times T \times E}{R \times F}$ = working pressure, in which

S = the tensile strength of the sheet in pounds per square inch.

T = the thickness of the sheet in inches.

E = the efficiency of the joint.
R = the radius of the curve to which the sheet is rolled.
F = the factor of safety assumed.

For the working pressure on the heads above the tubes, multiply the total cross sectional area in square inches of all of the braces by 6000 and divide the product by the number of square inches supported.

2. The strength of each unit section of solid plate is $0.375 \times 3.25 \times 60{,}000 = 73{,}125$ lb.

The shearing strength of two rivets is $(0.9375)^2 \times 0.7854 \times 2 \times 40{,}000 = 55{,}216$ lb.

The strength of a unit section of the sheet along the rivet holes in one row is $0.375 \times (3.25 - 0.9375) \times 60{,}000 = 52{,}031$ lb.

Obviously the weakest part of the joint is in the plate along the rivet holes, and the efficiency of the joint is $\frac{52{,}031}{73{,}125} = 71.1$ per cent.

3. One and one-fourth inch pipe should be used to connect the water column, which should be so set that water will just show in the glass when the tubes are covered 2½ in. Crosses with brass plugs, which may be removed to allow the pipe to be cleaned, should be used instead of elbows. The lower connection should enter the front head about 6 in. below the top row of tubes and be connected to the bottom of the column as closely as possible. A 1-in. blow-off should be used and the gage connected to the top of the column by a loop. Have no valves in column connections.

4. In selecting a pump for boiler feeding, one should be chosen which will deliver at a moderate rate of piston speed, say 50 ft. per minute, twice the average quantity of water required. The number of cubic inches of water delivered per minute, divided by the speed of piston travel in inches per minute, will, neglecting slip, give the required piston area.

$$\frac{2 \times 100 \times 30}{60} = 100 \text{ pounds per minute.}$$

$100 \times 28 = 2800$ cu. in. per minute.

$$\frac{2800}{600} = 4.66 \text{ square inches, area of water piston.}$$

This corresponds to a diameter of $2^{7}/_{16}$ in. The nearest commercial size is 2½ in., and for a 100-hp. boiler a 4 and 2 by 4 in. pump is the size that should be selected.

A suitable injector should have a range of delivery of from 300 to 600 gallons of water per hour, which may mean either the largest size made for 1 in. or the smallest for 1¼ in. connections.

5. The number of braces required will depend on the thickness of the head, the pressure carried, and the size and character of the braces. To find the number, multiply the area supported, by the pressure carried, and divide the product by the load allowed on the brace.

The area of a segment of a circle may be approximately determined by subtracting 0.608 from the quotient arising from the division of the diameter of the circle by the height of the segment, extracting the square root and multiplying this by 1⅓ times the height of the segment.

6. For lap seam and unknown quality of workmanship use the formula

$$p = \frac{60{,}000 \times t}{(L + 1) \times d}$$

where p = working pressure.
t = thickness of flue in inches.
L = length in feet between sections.
d = diameter of flue in inches.

Example: $\frac{60{,}000 \times 0.097}{7 \times 18} = 46$ lb.

For first class workmanship the factor 60,000 may be increased to 90,000: $\frac{90{,}000 \times 0.097}{7 \times 18} = 69.2$ lb.

7. The allowable working pressure on a Morrison flue is determined by the formula $p = \frac{14{,}000 \times t}{d}$

in which p = the working pressure.
t = the thickness of the flue in inches.
d = the mean diameter in inches.
In the example, by substitution

$$\frac{14{,}000 \times 0.375}{50} = 105 \text{ pounds.}$$

8. Single and double riveted seams are proportioned by the formula $P \frac{A \times N \times S}{T \times TS} + D$, in which

P = the pitch of the rivets.
A = the area of the rivet hole.
N = the number of rivets.
T = the thickness of the sheet.
S = the shearing strength of the rivets.
TS = tensile strength of the plate.
D = the diameter of the rivet hole.

Taking the shearing strength of the rivets at 42,000 lb. per square inch of cross sectional area and the tensile strength of the plate at 60,000 lb., the efficiencies of the several joints will be:

Plate	Rivet Hole	Pitch	Efficiency
Single riveted lap joint.			
5/16	13/16	1⅞	56%
3/8	15/16	2⅛	55%
7/16		2⅛	53%
Double riveted lap joint.			
5/16	13/16	2⅞	72%
3/8	15/16	3¼	71%
7/16		3¼	71%

9. Iron rivets were abandoned before this joint was used in the United States. Hence higher shear values should be used, 42,000 for single and 78,000 for double shear.

Taking these values, the strength of each unit section is:

1. Solid plate $6\frac{1}{2} \times .375 \times 60{,}000 = 146{,}250$ lb.
2. Four rivets in double shear, 1 rivet in single shear, $.5185 \times 4 \times 78{,}000 + .5185 \times 42{,}000 = 183{,}549$ lb.
3. Outer row $6\frac{1}{2} - .8125 \times .375 \times 60{,}000 = 127{,}968$ lb.
4. Middle row $(6\frac{1}{2} - 2 \times 0.8125) \times .375 \times 60{,}000 + .5185 \times 42{,}000 = 131{,}465$ lb.

There are other ways of failure, but in this joint the lowest value is found in number 3, and the efficiency is

$$\frac{127{,}968}{146{,}250} = 87.49 \text{ per cent.}$$

F. L. Johnson.

FOUR THOUSAND TONS of coal were put into the "Olympic" in 14¼ hr. at Southampton recently. This is a record coaling feat for the port and a world's record. Thirty-two gangs of men were employed, an average rate of 288 tons an hour being maintained throughout the night.—Compressed Air Magazine.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Gas Engine Overload Capacity

I SHOULD like to ask if, in putting in a plant for which the load is normally 100 hp. with a gas engine and producer of 110-hp. capacity, the load should increase to 115 hp., could I carry it the same as a steam plant if it is steady? J. W. B.

Breaking Gage Glasses

WE are troubled with our gage glasses breaking after being cleaned, and should like some of the readers to give us their opinion as to the cause of the trouble. Frequently our engineers take out gage glasses on water columns and at times the long 35-in. glass which is on our ammonia accumulator and after cleaning them very carefully with a soft wooden stick, never with anything to scratch them, and lay them aside for an hour or so, they break in several pieces.

Once in taking out our glass on the ammonia accumulator, which is 35 in. long, ¾ in. in diameter, we cleaned it with kerosene to get the greasy deposit from the inside and we thought that the cause, but since we have had the same trouble and did not use kerosene. We have tried wrapping the glasses to keep them from the surrounding atmosphere but to no avail. Engineer.

Why Use Circular Charts?

I WAS much surprised to find, on page 919 of the issue of Sept. 15, a reproduction of the "Graphic Control Chart."

Is there any valid reason for making any chart or curve that is plotted by hand, in the form of a circle? In most forms of curve drawing instruments their construction is such that they are limited to the circular form when they draw the curve, but this does not apply to curves drawn by hand, and all of the available material such as cross section paper, is adapted to the plotting of curves in horizontal lines, vertical lines or diagonal lines, but never circular. The circular chart is harder to draw, harder to read, requires a special blank to draw it on and is altogether unpractical. J. E.

Graphite in Boilers

I SHOULD like to say a few words in regard to graphite for boilers. I was engineer at a mine whose plant was equipped with 3 horizontal boilers, 2 60-hp. and 1 80-hp. The water although clear, deposited large quantities of scale and mud resembling chalk, finely pulverized.

Eight days was the maximum time without cleaning the boilers and 10 days meant blisters and they all showed it. The flues were choked until there was hardly more than ¼ in. between them. First I cleaned one boiler, neglecting the flues, and after washing out thoroughly, threw in a double handful of lubricating graphite, put in the head and filled the boiler with water, with the idea of cutting it in the following morning.

Everything went all right until noon the next day, when the water in the glass began to get muddy. By night I was so thoroughly frightened that I cut the boiler out, drained the water and knocked in the head. There was about 4 in. of loose scale on the crownsheet and the bottom of each flue was clean. The rest of the scale came off as soon as it was pushed loose from the top of the flues. Outside of reaming a few flues no further repairs were necessary. After that I would always throw in about ¼ of a pint of graphite every time each boiler was cleaned, and with lots of blowing down we could run 15 days without cleaning. E. Rammelmeyer.

Steam Engine Trouble; Pump Question

WE have a 14 by 20-in. single-eccentric Corliss engine, running at 60 r.p.m., tandem connected to an ammonia compressor. A few weeks ago the valve gear commenced to work badly and the head end steam would not release; this latter trouble however, was relieved by adjusting the reach rod.

After we started up, the governor hunted badly, causing the engine to slow down and then race. The governor belt was in good condition and did not slip, and changing the oil in the gag pot did not remedy the trouble. Furthermore, when the engine ran condensing the crank end steam valve worked badly; instead of the dashpot fulfilling its function the valve seemed to follow the wristplate up and down, but when changed over to noncondensing the trouble ceased.

I should like to hear from engineers who have had similar experiences.

The following question was asked a man who took a recent examination: "If a duplex pump was installed in the plant under your charge, that worked satisfactorily when you left the job and you did not return for 6 months and found the stroke one in. shorter than when you left and the pump had not been touched, what would be the cause?

Length of Connecting Rod

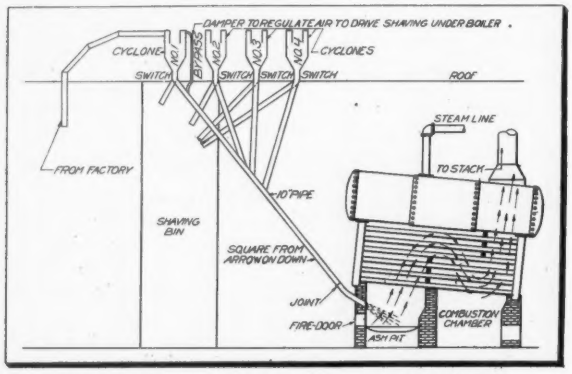
IN the July, 1912, number of Practical Engineer, C. D. S. asks how he can determine the proper length of a new connecting rod for an engine which has no rod. The answer given by A. L. R. shows one method of finding the length of the rod which is correct, but I think the following method is much simpler. Move the crosshead to the head end of the stroke until piston strikes the head, make coinciding marks on the crosshead, and on the guides; then move the crosshead to the crank end until the piston

strikes the other head; make a mark on the guides coincident with the mark previously made on the crosshead.

Now find a point exactly midway between the 2 points on the guides and make a mark. Move the crosshead back until the mark on the crosshead is exactly on the mark at center of guides. With the crosshead in this position, measure from the center of the wristpin to the center of the crank shaft. This distance will be the correct length of the connecting rod from center to center of brasses, neglecting clear ance which should be deducted. L. T.

Burning Shavings

IN the Dec. 1 issue of Practical Engineer, on page 1203, B. O. G. asks for information in regard to burning shavings with other fuel. At the plant where I am employed I have such conditions and I think the accompanying sketch will give him the information wanted. There are 4 cyclones, all connected to one header 10 in. in diameter, which is connected to the boiler furnace with a swinging joint, so that it can be taken down when the boiler is not in service.



ARRANGEMENT OF BOILER FOR BURNING SHAVINGS

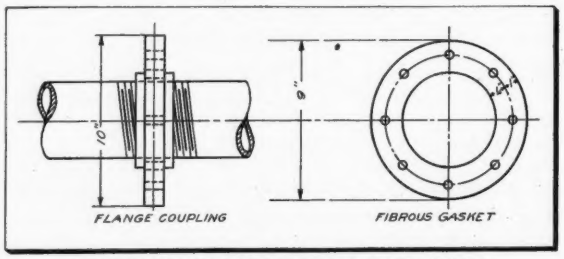
There is a 6-in. bypass on No. 1 cyclone, so as to get air to drive the shavings under the boiler, and also to spread them. There is a damper close to the cyclone to regulate the amount of air required. I have the McNaull water tube boilers, but this would work on a Dutch open just the same, if not better, because you could come straight down with the shaving pipe and it would take less air. We burn coal and wood with our shavings when the shop is running light, as there is not enough shaving to keep up steam; by this method we have no dust in the boiler room.

B. A. Held.

Gasket for Traction Engine

REPLYING to inquiry by H. H., page 1202, Dec. 1, 1912, issue of Practical Engineer, a metallic gasket would be best for service on the traction engine in question, especially in the place where it is to be used. Sheet copper will not crawl or squeeze out. The required thickness of the sheet from which the gasket is cut necessarily depends on the condition of the surfaces between which the gasket is to be placed. Its thickness should be such as will fill in the asperities properly. If a copper gasket is used it should be well annealed before placing it, so it will soon fill in and be tight.

A fibrous gasket may be used, however, and possibly would prove as efficient and satisfactory as the metallic packing. In the case of fibrous packing in a joint of the kind under consideration one must pull up good and hard on the studs or bolts as the packing warms up after it is in place, so then it is not so likely to blow out; also, the action of heat on fibrous packing (as for example rubber filled packing), tends to make them soft at first, and much of the gasket will squeeze out if the bolts are pulled up as they should be and we will get a good joint. After a few days the packing in the joint becomes dry and brittle, hence the necessity of screwing the joint up hard so as to protect the packing against tendency to crack and crumble due to vibrations in the mechanism. I always have the best luck with ⅛-in. sheet packings, no matter where I use them, and would recommend them to all who have to do with heat and steam apparatus. The sketch shows my method of cutting a fibrous gasket for a 10-in. flange coupling or a joint of any



DIMENSIONS OF GASKET FOR A GIVEN JOINT

kind. I always make the gasket smaller than the flange or other joint, but when it is moved up and the bolts pulled up as they should be the gasket will spread out and fill in under all the surfaces, and no packing has been wasted. T. C. R.

ROLLING MILL reversing engines are frequently rated by horsepower. We hear about 10,000-hp. engines, 20,000-hp. engines, and even 30,000-hp. engines. The engine size which for years was standard in American mills, namely 55 by 60 in., when run with full steam admission will develop over 25,000 hp. at a speed of 250 r.p.m., as may be seen from the curve Fig. 1. And yet any such rating is arbitrary and misleading. The engine works with full steam admission only at low and medium speeds. When running at high speed, it works with greatly reduced steam admission, so that the horsepower developed by the 25,000-hp. engine never exceeds 6000. In a test made on a blooming mill of the Pittsburgh district the horsepower in the early passes is about 4000; it rises to less than 5500, and in the last pass it drops again below 4000 in spite of the greatly increased speed. It is obvious that the steam engine cannot develop more power than the mill will take.

The desire to rate everything mechanical by horsepower has led to some peculiar expressions. We find 1000-hp. boilers, 1000-hp. feed-water heaters, 1000-hp. condensers, 1000-hp. exhaust heads, etc.

On account of the before mentioned fact that the engine is not allowed to develop more power than the mill will take, it is probably wise to rate the rolling mill reversing engines solely by their cylinder sizes.

In this connection it may be of interest to note that Macintosh-Hemphill & Co. has just completed a 44 and 70 by 60-in. twin tandem compound reversing engine. The Mesta Machine Co. has just completed a 46 and 76 by 60-in. twin tandem compound reversing engine and is building an additional engine of the same size for Gary, Ind.

PRACTICAL MATHEMATICS

Practical Problems in Lining Up an Engine, Steam Piping and Piping Dimensions

THERE are several interesting problems that can be solved in connection with articles that appeared in the Jan. 1, 1913 engine number of Practical Engineer. Referring to the article "Lining up the Engine," under the sub head "Truing the Frame," on page 6, the following problem suggests itself:

Suppose that the cylinder is out of line to the left 0.018 in., and the cylinder is 60 in. long, the outside diameter of the head being 32 in. To find out how much to remove from the end of the frame, multiply the diameter of the head by the amount shown out of line, and divide by the length of the cylinder over all. In this case, $32 \times 0.018 + 60 = 0.0096$ in., or say 0.01 in. to be filed off at the thickest place, and diminished to nothing at the opposite side of the frame end, in this case the lefthand side of the flange.

To illustrate the use of the curves, Fig. 2, in the article "Steam Piping," page 7, assume that a pipe run 75 ft. long is to carry steam at a pressure of 125 lb. and with 200 deg. superheat. At that pressure the temperature will be 353 deg. and 200 deg. superheat would make it 553 deg. Assuming the temperature of the air to average about 53 deg. would give the temperature rise as 500 deg. We start from the lefthand side of the diagram on the line corresponding to 75 ft. in length, go to the right to the intersection with the vertical line for 500 deg. rise.

We find that we are between the curves for 3½ and 3¾ in. expansion. It would be safe, therefore, to provide for 3¾ in. come and go, as the temperature range might vary a little more than figured.

Since the expansion is directly proportional to the length, if we wish to figure for a run more than 100 ft. in length, we can take the expansion for 100 ft. and multiply it by the number of hundreds feet in the run. For example, in a run of 245 ft. to carry steam at 300 deg., we note that the intersection of the 100 ft. horizontal and the 300 deg. vertical is about half way between 2½ and 2¾ in. expansion. Consider this as 2 5/8, that is the expansion for 100 ft. This is to be multiplied, for 245 ft., by 2.45, which gives us 6.45 in. or approximately 6½ in. expansion to be taken care of.

Take the case of a line of 2-in. pipe 50 ft. long to carry steam at 125 lb. pressure. From the steam table, the temperature at 125 lb. gage or 140 lb. absolute is 352.8 deg. F. This would be 300 deg. rise above the atmosphere, and from Fig. 2 the expansion would be 1.3 in. Looking at the curves in Fig. 3, the curve for 2-in. pipe crosses the 1-in. expansion line on the 11-ft. vertical line; hence, a bend 11 ft. long is needed. By the table, Fig. 4, 2-in. pipe should have at least 3 in. length straight at each end of the bend or 6 in. total which requires 11½ ft. to be made into a bend. If it be a double bend or circle, the radius would be 3 ft. 4½ in. For any other form of bend the length could be made up of arcs of not less than 10 in. radius, and straight lengths most convenient. In this case the radius needed for length far exceeds the minimum allowable.

Again take a 6-in. exhaust line 30 ft. long, carrying steam at 3 lb. pressure. The temperature is 222 deg. F. or a rise of 172 deg. which would cause 5/16 in. expansion, calling for 11 ft. of pipe in the bend. The straight ends need 13 in. or about 1.1 ft. leaving 9.9 ft. for the bend, the circle having 3 ft. 1½ in. radius.

Referring to page 9, under the subhead "Pressure Drop in Straight Pipes, Entrance to Pipes, Elbows and Globe Valves," let us consider the drop in pressure in the pipe for a simple noncondensing engine rated at 100 hp., with a steam consumption of 30 lb. per horsepower-hour, running fully loaded and that the steam main connecting the engine and the boiler is 100 ft. in length and 4 in. in diameter; that it has 2 short ells and 2 globe valves. Under these conditions 50 lb. of steam a minute would be required. To determine the drop in pressure through the 100 ft. of pipe we refer to the steam tables and find that the density of steam in pounds per cubic foot at 70 lb. gage, 85 lb. absolute, is 0.201+ lb. The value of C for a 4-in. pipe is 3969. Substituting figures in the equation,

$$p^1 - p^2 = \frac{2500 \times 100}{3969 \times 0.201 \times 1024} = 0.3+ \text{ lb.}$$

The resistance at the entrance is equal practically to a straight pipe of length equal to 60 times its diameter. In this problem, using a 4-in. pipe, it would amount to $(60 \times 4) \div 12 = 20$ ft. of pipe or 0.2 the loss in the main 100 ft. long; $0.3 \times 0.2 = 0.06$ lb. For a short elbow the friction is equal to that in a straight pipe whose length is 40 diameters; for the 2 ells the equivalent length will be, $2 \times 40 \times 4 \div 12 =$ about 26 ft.; and $0.26 \times 0.3 = 0.078$ lb. loss.

For a globe valve the loss in pressure is that for a pipe whose length is 60 diameters; for the 2 valves this will be, $2 \times 60 \times 4 \div 12 = 40$ ft.; and $0.4 \times 0.3 = 0.12$ lb. loss.

The total loss of pressure will then be $0.3 + 0.06 + 0.078 + 0.12 = 0.558$ lb.

On page 9 the rules given in the article "Piping Dimensions" can be expressed in the shape of a formula as follows: $\frac{A \times S}{V} \times 144$, in which A = cylinder area in square feet, S = piston speed in feet per minute, and V = steam velocity in feet per minute.

As a practical illustration, assume that it is required to find the sizes of pipes for an engine with a cylinder diameter of 12 in. and a stroke of 24 in., operating at 80 r.p.m. Area of cylinder square feet $= (6^2 \times 3.1416) \div 144 = 0.78$. Piston speed in feet per minute $= (80 \times 2 \times 24) \div 12 = 320$. Assume a steam velocity of 8000 ft. and an exhaust velocity of 4000 ft. a minute, then the area of the steam pipe in square inches will be $\frac{320 \times 0.78}{8000} \times 144 = 4.49$ sq. in. The area of the exhaust pipe in square inches will be $\frac{320 \times 0.78}{4000} \times 144 = 8.98$ sq. in.

FROM DIFFERENT American fields, samples of at least one barrel each of 11 different fuel oils, the lowest being an asphalium base oil with a specific gravity of 25 deg. Beaume, were recently secured by the Blanchard Machine Co. On these tests were run for from 40 to 100 hours each, long enough to establish conclusively that the Blanchard oil engine will not consume over 0.1 U. S. gallon of fuel oil per brake horsepower hour, provided that this oil is not heavier than 26 deg. Beaume and contains at least 18,000 B. t. u. per pound, to be free from acid and to contain not over 0.3 of one per cent of sulphur or water.

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AN ENGINEERING MENU; AIR, WATER, FUEL, CURRENT AND LIGHT ON THEM ALL.

Warmth and Fresh Air are essentials to comfort and good health, and the importance of supplying both to those who are indoor workers is now universally recognized by engineers. Just how much is enough, and how best to secure the proper supply are not so well known, hence frequent inquiries for information which have resulted in a series of articles by Charles L. Hubbard, the first of which appears in this issue.

A modern complete system has provision not only for making certain that the rooms are warm, but that the air is properly washed, moistened, tempered and supplied without creating drafts. Also that hot water is supplied for lavatories, and, the very newest wrinkle, that vacuum is created for drawing away the dirt, instead of aggravating the occupants and irritating the microbes by stirring them up with brooms and dusters.

Mr. Hubbard has devoted many years to the solving of problems in this field, and readers of Practical Engineer will be given the benefit of this in articles which will treat all these branches in detail.

Slide Rule computations are so much easier than pencil and paper and so much safer than guessing that the only excuse for either is not knowing about the Slide Rule or not being on good enough terms with it to have confidence in it. During 2 years past you Practical Engineer readers have been getting frequent introductions and now H. L. Sherman, who has made the rule his daily chum has agreed to bear witness of the service it does him and to show just how he uses it every day. This story will start at once, and Mr. Sherman will be glad to answer all questions and tell specially just how to get the most out of the "figuring stick."

The continual and more urgent demands made upon the operating engineer for higher efficiency in producing power requires him to know the why and wherefore of everything that takes place in his plant. The simple fact that coal burns is not enough nor is it sufficient to know that your feed water is hard and forms scale. To get further detailed information and know how to use the information after it is secured requires a working knowledge of chemistry as applied in the power plant.

It is with the idea of aiding the engineer in his efforts to increase the efficiency of his plant, that a series of articles upon Power Plant Chemistry will be published in Practical Engineer beginning in the near future. The articles will deal first with coal, what it contains, how it may be analyzed, the chemistry of combustion, determination of heat values, etc. Other fuels will come in for their share of treatment as will also, flue gases, feed waters, oils, certain metals, ammonia, salts used in refrigeration, storage batteries, in fact it is proposed to give, in a practical comprehensive way, methods by which the engineer can in-

vestigate all the chemical changes which are taking place in his plant and determine when these are working towards highest efficiency.

Electricity plays such an important part in the equipment of modern buildings that it behooves every engineer to keep himself informed on this subject. A series of articles entitled "Practical Electrical Engineering" has been running in Practical Engineer for sometime. Beginning with the elementary principles they have covered the theoretical and practical considerations governing the characteristics of both alternating and direct current apparatus including motors, generators, rotary converters and transformers.

In future articles the design of electrical machinery will be explained in a practical manner, various types of instruments will be described, and in fact all branches of the subject that are essential for the practical man to know will be fully dealt with.

It is not sufficient to know why wheels revolve, but every operating man should be able to solve any problem met in his profession and a knowledge of mathematics in the higher branches is essential. As an aid to the readers who have not had the opportunity to study mathematics the series of articles entitled "Practical Mathematics" will, we believe, be of material assistance to those desiring a working knowledge of this subject. Beginning with common fractions the various branches to and including logarithms have already been dealt with by the use of practical problems that are liable to be encountered every day.

In future articles algebra, geometry and trigonometry will be explained in such a manner as to enable the readers readily to comprehend the subject matter. In this issue miscellaneous problems illustrating the application of rules and formulas appearing in the Jan. 1 number of Practical Engineer are given to enable the reader to gain a clear understanding of their practical value.

ISOLATED GAS LIGHTING*

Systems for Single Buildings or Portable Plants Such as Camps or Quarry and Construction Work

By Eugen Becher

THREE systems are in common use; gasoline, acetylene and Blaugas. Gasoline may be vaporized hot by a flame or cold by a blower, the former being cheaper but more troublesome and somewhat dangerous. Regulation must be employed to control the percentage of gasoline in proportion to the temperature of the air, so that no more will be supplied than the air can retain in suspension.

Ordinarily 5.5 gal. of gasoline are needed to make 1000 cu. ft. of gas of a specific gravity 1.5, having 14.5 per cent of gasoline vapor and a heat value of 600 B.t.u. per cu. ft. Such gas is well suited for lighting and heating; it forms an explosive mixture with air between the limits of 13.8 per cent gas to 86.2 per cent air and 34.4 per cent gas to 65.6 per cent air, the mixture containing 2 to 6 per cent gasoline. If the temperature is lowered to 45 deg. F., some liquid gasoline will be deposited, therefore it is necessary to have pipes kept above that temperature by insulating or heating.

Acetylene

THIS product of the action of water on calcium carbide requires about 1 lb. of carbide at a cost of 4c to produce 4.25 to 4.5 cu. ft. of gas, having a heat value of 1440 B.t.u. per cu. ft. Used, as is commonly done, in an open burner 1 cu. ft. an hr. will yield 45 candlepower. Heat is liberated during the formation of the gas and unless carried away may produce serious accidents. With air, acetylene forms an explosive when more than 2 per cent and less than 49 per cent acetylene is mixed with 98 to 51 per cent air, the upper explosive limit often being higher if the air is very dry or in vessels or pipe of large diameter, say over 1 in.

Acetylene gas is not well adapted for heating, as burners give much trouble unless kept absolutely clean.

Compressed acetylene is dangerous, especially if above 2 atmospheres, 30 lb., pressure, but may be dissolved in acetone and transported with reasonable safety. This makes, however, a system too costly for ordinary use.

Blaugas

THIS is a mixture of hydrocarbon gases liquefied under high pressure and low temperature and carrying in solution a large quantity of gases usually permanent, such as methane and hydrogen, the whole remaining liquid in form under high pressure and normal temperature. The liquid will all be reconverted into gas, however, on being allowed to expand to a lower pressure.

The gas is manufactured by distillation from crude or fuel oil or similar material, and is then cleaned, cooled and compressed to about 80 atmospheres, 1200 lb. per sq. in., and charged into steel bottles, each holding 20 to 25 lb. of the liquefied gas. A pound of the liquid will give 12.5 cu. ft. of expanded gas, with heat value of 1800 to 2000 B.t.u. per cu. ft.

Expansion takes place through regulating and reducing valves to about ½ lb. per sq. in. in the service pipes. A cubic foot an hour will develop 80 candlepower in an incandescent burner and gives excellent results for both lighting and heating.

Explosive mixtures are formed only between the limits of 4 per cent gas to 96 per cent air and 8 per cent gas to 92 per cent air, a range of only 4 per cent as against 20 per cent for gasoline gas and 47 per cent for acetylene gas.

No special apparatus is required, the bottle being simply attached to the system, used until empty and then replaced by a full bottle. Two bottles are usually connected at a time, one in use and one in reserve. The cost compares favorably with other gases, so that its use is likely to increase rapidly.

*Abstract of a paper before the Amer. Soc. of Agricultural Engineers.

Replacing of 44 consolidation engines by 25 Mallet compound locomotives on the Hinton Division of the Chesapeake and Ohio Railroad, has resulted, it is stated, in a saving of 37.55 per cent of the cost of handling the freight traffic on this division. As the Mallet locomotives are more costly than were the consolidation locomotives, this saving is reduced by the amount of the interest and depreciation of the excess cost of the Mallet engines. Nevertheless, there appears to be a clear saving of more than 30 per cent of the total cost of handling the freight traffic.—Machinery.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

REGULATING THE WATER LEVEL

AT various times in the past, tests have been made on feed-water regulators by engineers, and sometimes reports have been received that the closest regulation obtainable was 3 or 4 in. Investigation shows that in most cases, the difficulty was due to failure in following out directions for installing the regulator, but there were some cases in which regulation closer than 1 in. was impossible because the water level itself as shown in the gage glass fluctuated over 5 or 6 in. The Neco regulator depends for its operation upon the admission of steam or water into the expansion tube, the steam flow being dependent upon the level of the water, that is, whether it is above or below the gage connection to the upper end of the tube.

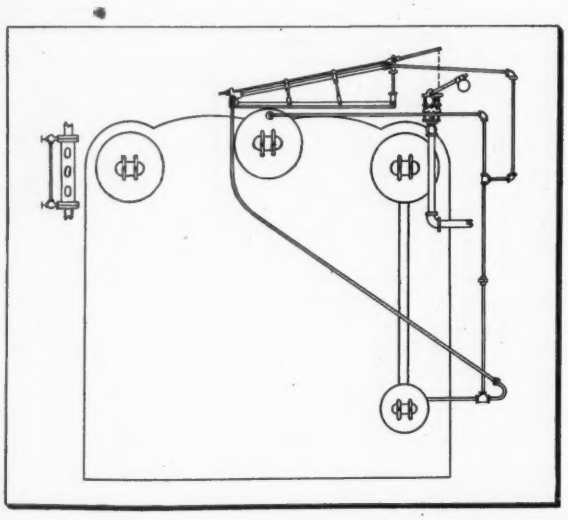


FIG. 1. INDEPENDENT WATER COLUMN CONNECTION FOR THE NECO REGULATOR

It is, therefore, obvious that if the regulator triangle connections are made at points where a 5 or 6-in. fluctuation in water level takes place, it will be practically impossible to secure 1-in. regulation. This fluctuation of level is due to the fact that above the point of the hottest gases, the boiling water is agitated and causes a hump, or knoll, in the surface of the boiler water. This hump often rises and falls rapidly, and as the ordinary water column is usually connected so as to indicate in the gage glass the water level of this pump, the regulator, which is connected to the regulator water column, is also affected by the hump.

To get around this difficulty, the Standard Neco Regulator is connected as shown diagrammatically in Fig. 1. An independent water column of ordinary pipe is connected at the lower end to an undisturbed boiler water level, usually the mud drum, and the upper end is connected the same as in the case of the regular water column. The auxiliary water column will then have a level which varies so slightly that regulation within ¼ in. is easily secured, feed being exactly in proportion to the evaporation.

Further, increase in efficiency is secured by this method of control when fires are drawn or cleaned. When the fire dies down, the hump falls to the true level in the boiler, and any regulator connected to the regular water column will then increase the water sent into the boiler, thus reducing the surface for steaming at a time when it should be increased. When the fires are renewed, the hump rises and causes the

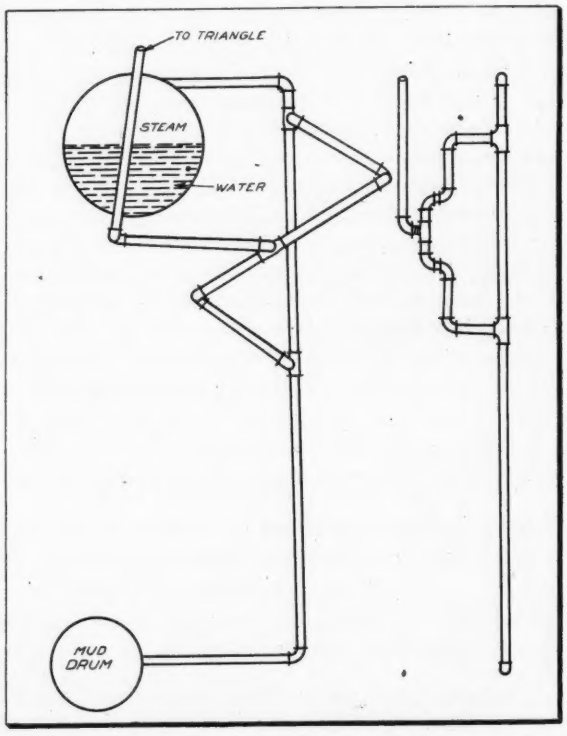


FIG. 2. METHOD OF DETERMINING BEST POINT FOR TRIANGLE CONNECTION OF NECO REGULATOR

regulator to cut down the water supply, at a time when extra water might well be turned into the boiler.

With the auxiliary column connection, the opposite effect will take place, since when the hump falls, it will raise the level in the rest of the boiler, and therefore the regulator will tend to cut down the water supply. When the fire starts up again and the hump rises, it will draw water from the rest of the boiler, thus lowering the level in the auxiliary water column,

and causing the regulator to admit more water, which the newly built fire can well evaporate. Tests made with steam flow meters in the General Electric Co.'s Testing Dept., show that this feature may result in an increase of 2 per cent in the boiler efficiency.

Figure 1 shows the connections diagrammatically, as arranged for the independent water column on a Stirling boiler. This placing is by no means fixed as the regulator may be put anywhere, except that the triangle should be as near the water column as convenient and should be above the point of highest water level. The exact point at which the connection to the upper end of the expansion tube is to be made, will depend upon the type of boiler, firing, and local conditions. A simple method by which this point can easily be determined is shown in Fig. 2. Piping is made by movable joints, so that the connection level can be changed, and after this point has been determined for best operation, the temporary piping is removed and permanent connection made, as shown in Fig. 1. This method of connection, and also the regulator shown in the illustrations, are the products of the Northern Equipment Co., of Chicago, Ill.

BUCKEYE BOILER SKIMMER

Recent Improvement Adapting It to Water-Tube-Boilers

CLEANLINESS on the inside of the boiler is essential if the most efficient results are to be obtained, but the methods best adapted for this purpose depend upon the character and amount of scale-forming material in the water. Nearly all impurities at sometime during the process of forming scale, float in the boiling water. This has led to the design and extensive use of the Buckeye boiler skimmer.

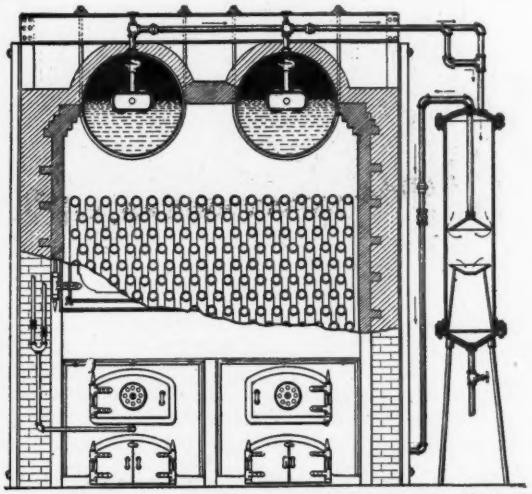


FIG. 1. DIAGRAM SHOWING ARRANGEMENT OF BUCKEYE BOILER SKIMMER

Figure 1 shows the complete outfit as applied to a water-tube boiler, but it is equally adaptable to tubular or marine type boilers. The floating skimmer shown in Fig. 2 is a wide-mouthed funnel suspended by a tubular arm. The skimmer is always submerged to the same depth, irrespective of the water level, except in extreme cases, being kept in this relative position by means of the floats.

After the floating impurities have been collected by the funnel, they pass through the tubular arm and flexible joint to the outside piping through which they are conducted to the precipitator. Here the water is discharged into the receiving chamber between the top head of the precipitator and the head of the inner tube. There being a larger body of water farther removed from the boiler, and consequently cooler, in the precipitator the incoming water is cooled a few degrees and then passes out through perforations and downward between the inner tube and main shell until it reaches the lower end of the tube, when it changes its direction of flow to an upward course while the sediment separates from it and is collected in a sediment chamber below. The clear water then returns to the boiler relieved of its impurities. The sediment that settles in the chamber is blown out from time to time, as conditions demand.

FIG. 2. SKIMMING DEVICE SHOWING SUPPORT

Owing to the unequal pressure in the boiler a continuous circulation is kept up through the skimmer and precipitator as long as the boiler is in use. As fast, therefore, as the impurities float to the surface they are drawn off and not allowed to settle upon the boiler shell or tubes to form scale.

Recently the skimming device was improved which enables it to be used more efficiently than formerly in water-tube boilers, by providing a support for the funnel and floats which prevents them from dropping so low that the funnel is entirely submerged when the water becomes abnormally low.

The Buckeye Boiler Skimmer Co., of Toledo, Ohio, is the manufacturer of this device.

LARGE ANGLE TYPE STRAINER

RECENTLY 2 large multiple water strainers were built by the Lagonda Manufacturing Co., of Springfield, Ohio, for the Southern California Edison Co., for removing fish, sticks, leaves, seaweed, ice, etc., from the water supply to its power plant. This strainer is of interest, not only because of its large size, 30 in., but because it is of the angle type, that is, the water passes out in a direction 90 deg. from the entrance.

These 2 30-in. strainers and a similar one of 36 in., were specially designed to meet peculiar conditions, as are many of the strainers which the Lagonda Co. has built. The strainer contains 3 filtering baskets, each one of which has a free straining area equal to that of the pipe line. That is, when one of the baskets is out of service for cleaning, the 2 remaining have an area at least twice that of the pipe line, so

that there is little resistance to the flow of water or loss of head caused by friction. The low velocity in the strainer also permits of ample time for impurities to settle and eliminates any erosive action from water moving at high velocity.

A further point of interest is that the entire strainer can be buried beneath the power plant floor, only the hand wheels and top of the bonnet projecting above. Any one of the individual straining baskets can be removed from the body of the strainer by merely turning one of the hand wheels, and the removal of one basket does not interfere with the operation of the other 2 baskets. When the basket to be cleaned has been elevated to the cleaning chamber, it is taken out in an upright position and carried to some convenient place and emptied.

The Lagonda Manufacturing Co., is now building strainers for use in lines from 2 to 48 in. in diameter, the strainers containing from 2 to 6 baskets.

THE VANCE PATENTED COMPOUND BLOWOFF VALVE

A NEW blowoff valve, designed by C. E. Vance, is being placed on the market by the Geo. M. Newhall Engineering Co., of Philadelphia. The unique feature of its construction is a double valve arrangement to insure absolute tightness when closed. Particular attention has also been given to the protection of the valve seats from the force of the blowoff sludge, as it comes from the boiler.

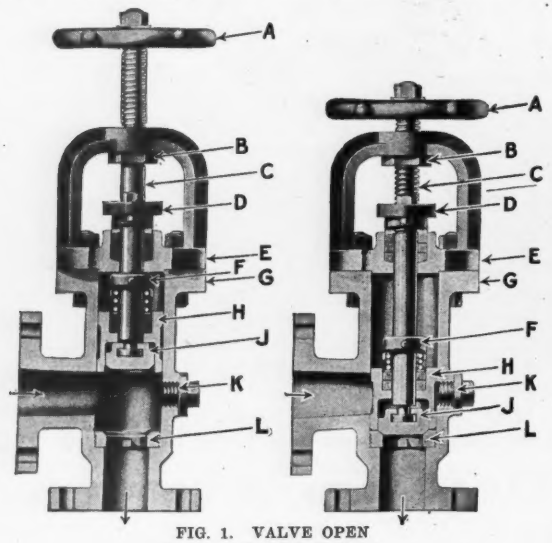


FIG. 1. VALVE OPEN
FIG. 2. VALVE CLOSED

The plunger acts as a valve and is made in such a way that it protects the disc valve in all positions from coming in contact with destructive elements. Each valve makes an individual seating, the plunger valve first and the disc valve sometime after. When the plunger passes the inlet in closing, the flow is practically cut off, and only a thin sheet of water passes over both seats to clear them of sediment until the plunger valve seats; when tight, the disc valve seats with no water passing through, just as if the valve were not in use.

On opening, the disc valve leaves its seat first, and moves up into the protective covering of the plunger valve out of harm's way before the plunger valve begins to move from its seat. The disc valve works on a slip joint, permitting easy removal, and has enough play to make seating easy and without strain.

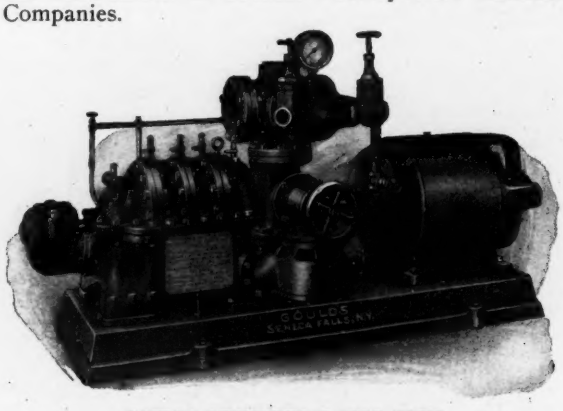
Protection of the valve seats from the destructive elements of the blowoff has been accomplished by placing them below the direct line of the sludge as it comes from the boiler; these seats are removable to permit regrinding or renewing as circumstances may require.

The extra heavy valve stem, screws through a bronze bushing, which is accurately fitted into the yoke of the valve. Stuffing boxes are made deep to give plenty of room for sufficient packing to keep the valve absolutely tight at this point; the valve is made extra heavy throughout, equipped with standard flanges and large handwheel to permit of easy operation.

NEW CENTRIFUGAL FIRE PUMP

THE accompanying illustration shows a new design of centrifugal fire pump just developed by The Goulds Mfg. Co., Seneca Falls, N. Y., to obtain ruggedness and strength, liberal size water ways and easily accessible parts, with simplicity and reliability.

The outfit is furnished complete with pump, alternating or direct-current electric motor, or steam turbine, bed plate and all fittings required by the fire insurance companies, and it has been approved by the Association of Mutual Factory Fire Insurance Companies.



GOULDS CENTRIFUGAL FIRE PUMP

Four sizes are furnished, with capacities of 500, 750, 1000, and 1500 gal. per minute—being sufficient for 2, 3, 4, and 6 effective fire streams respectively.

The outfit illustrated is the 500-gal. equipment for 2 effective streams. With 250-ft. leads of smooth hose and 1⅛-in. hose nozzles, the pressure at the nozzle is 50 lb. per sq. in. This will produce an effective stream in a modern wind at a vertical height of 70 ft. and at a horizontal distance of 63 ft.

The motor with this outfit runs at 1700 r.p.m. and has an output of 50 hp. The overall dimensions of the complete outfit are: Length 9 ft. 7 in.; width 6 ft. 3 in.; height 4 ft. 9 in.

THE ALABAMA POWER DEVELOPMENT CO.'s plant at Jackson Shoals will be in operation by early spring according to reports received from Gadsden. This company is taking over the control of many steam plants in various cities in Alabama and is spending large sums in development work.—The Tradesman.

SAFEGUARDING CONTINUITY OF ELECTRIC POWER SERVICE

AT the present time, the ubiquity of electricity is practically an accomplished fact. To realize how dependent the people are upon the electric current, it is only necessary to be at the power house end of the telephone when the power is off and an exasperated public has waited for what they consider a reasonable length of time for its restoration. A shut down of the machinery may mean not only serious delay in finishing work but also men paid high wages standing around idle. This condition makes it imperative that every device be employed which makes for continuity of service.

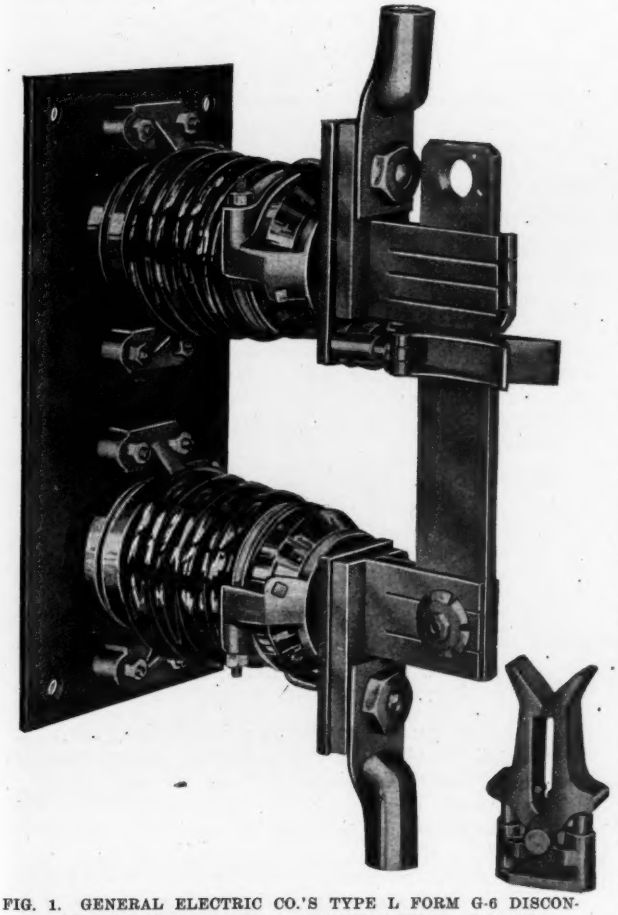


FIG. 1. GENERAL ELECTRIC CO.'S TYPE L FORM G-6 DISCONNECTING SWITCH WITH LOCKING DEVICE (LOCKING DEVICE SHOWN AT RIGHT)

The illustration shows a locking device that effectually prevents the blade of a disconnecting switch from opening except under the direction of the operator. Instances are on record where the blade of a disconnecting switch not protected by this device has been thrown open or partly open by magnetic repulsion and destroyed, when a short circuit has occurred on the line, not only resulting in the loss of the switch but also putting the circuit on which the switch was installed out of commission till a new switch could be installed unless there were duplicate circuits.

The safety catch or locking device is a unit in itself and can be applied by anyone to any GE type L, from G-6 switch merely by clamping it to a support placed between the clip block and the insulator cap. It is of rugged design and is operated with a switch hook. This locking device consists essentially of 2 brass bell cranks hinged together at the ends of the 2 shorter arms and held closed by compression springs. The projections or jaws in the outer ends of the 2 longer arms close in front of the blade thus preventing the latter from coming out of the clips. Each bell crank is provided with a dog which moves in a slot in the bell crank's elbow, the dog being hinged at this point. Two compression springs, one pressing outwardly from the switch base against the elbow of each crank and also against the dog, keep the bell cranks closed and the dogs pressed against the back of the switch blade.

To open the switch, the outer ends of the bell cranks are pressed back away from the blade allowing

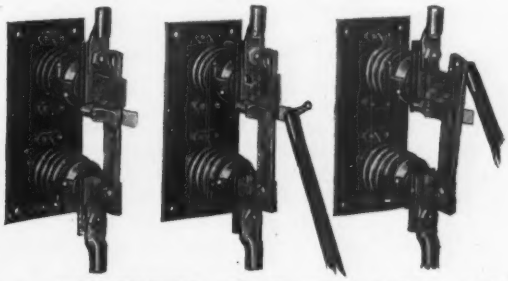


FIG. 2. DISCONNECTING SWITCH WITH LOCKING DEVICE. ILLUSTRATION SHOWS MANNER OF OPENING SWITCH

the dogs to come forward so as to rest upon the sides of the blade, in which position they hold the jaws in front of the blade apart allowing the switch to be opened. Withdrawing the blade of the switch from between the dogs causes the jaws to close automatically against the sides of the blade and to snap shut as soon as the blade is completely withdrawn.

As the outer edges of the jaws are beveled the switch blade can be readily pressed back in the clips into the closed position, when the jaws close automatically in front of the blade locking the latter in the closed position. The operator can't forget to lock the switch closed as it automatically locks itself.

This device is made in sizes to fit 300, 600, 800, and 1200-amp. switches as standard and can be furnished for a switch of any capacity. It has been on the market for a comparatively short time, yet it is being used by practically all the important electrical operating companies in the United States.

The locking device described above is manufactured by the General Electric Co., Schenectady, N. Y.

THE DETECTORPHONE

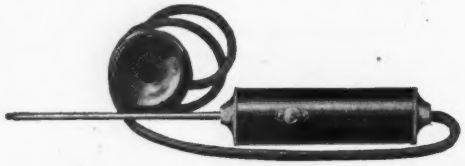
THE Detectorphone, or by a more descriptive name the "mechanical stethoscope," is an electrical instrument which employs the principle of the microphone for the detection of mechanical trouble.

It consists of a sensitive microphone and a 6-in. dry cell enclosed in a metal cylinder, a high resistance telephone head-receiver with flexible connecting cord and 2 metal rods, one of which is straight and the other curved at right angles, as shown in the accompanying cut.

Microphone, battery and receiver are connected in series, the circuit being closed by means of a push button on the battery cylinder. The metal rod is

screwed tightly into the front of the instrument through a bushing and engages with the diaphragm of the microphone. The battery can be removed if necessary by giving the metal cap, which constitutes the base, a half turn then pulling out.

In service, the metal rod is pressed against the part to be tested as for instance a motor or engine bearing, a pump, or a waterpipe, the head receiver is held tightly against the ear and the push button is pressed down to close the electric circuit. The vibration of the machine being tested is transmitted to the receiver and there made audible by a slight humming or buzzing sound. The slightest irregularity of opera-



THE DETECTORPHONE

tion which may be inaudible to the unaided ear, can thus be instantly detected by the humming noise produced in the receiver.

It is first necessary to make test of the sounds made by the machinery while in perfect running condition. After short practice, then the irregular sounds produced by defects in the operation of a machine can be readily analyzed, thus preventing what might have been a serious and costly shut down.

The Detectorphone is of great value to all engineers in their work, whatever it may be, due to its extensive and varied application.

NEWS NOTES

PLANS FOR IMPROVEMENTS in the municipal light plant at Richmond, Ind., have been presented before the board of public works. The changes decided on will cost approximately $70,000.

EPPING-CARPENTER COMPANY, manufacturer of pumping machinery, has opened a district sales office at 131 State Street, Boston, Mass., in charge of James J. Hart, formerly with the International Steam Pump Company and the Warren Steam Pump Company.

WALTER GERHARDI, Ludenscheid, Germany, desires to correspond with designing mechanical engineers and draftsmen who have had experience in designing special machinery for metal working, giving American references and any special designs that they may have for sale.

THE WHEELS OF THE NEW POWER HOUSE erected on the new dam across the St. Joseph river in Elkhart, Ind., will turn about June 1. This plant will yield 20,000 hp., gathered from the waters of the mighty river it has harnessed. The company promises not only to furnish power for the St. Joe Valley, but to furnish "juice" for Goshen and other surrounding cities and towns.

CONTRACTS HAVE BEEN LET by the People's Power Co. for installing another 12,500-kw. unit at the power plant in Rock Island, Ill. The unit is to have a maximum rating of 20,000 hp., and it will be 50 per cent larger than the 8000-kw. unit installed recently and now in operation. With the building changes necessary, the installation of the unit will mean an expenditure of about $200,000. It is planned to have the work completed this summer and the new machines in operation by Jan. 1, 1914.

THE AMERICAN ENGINEERING CO., builders of the Taylor Stoker, on January 1, 1913, opened a Cincinnati office at 412 Traction Building.

J. F. WARE, traveling sales manager of the Hoppes Manufacturing Co., Springfield, Ohio, has been elected Director and Vice President of that company.

THE LAGONDA MFG. CO., of Springfield, Ohio, has discontinued its Pittsburgh office and business in that territory is now handled by James H. Johnston, manufacturers' representative.

THE INTERNATIONAL ACHESON GRAPHITE CO., of Niagara Falls, N. Y., has appointed Richard Cary sales manager of its lubricant department, and the plans provide for a wider and more thorough distribution of its products, especially through the regular trade channels, and by thoroughly co-operating with the dealers.

S. ROSENZWEIG, mechanical engineer of the Erie City Iron Works on his present lecture tour of Western Universities will include the universities of Cincinnati, Ill., the Armour Institute of Technology and probably Purdue University. Mr. Rosenzweig will also talk before the A. S. M. E. branch of the Brooklyn Polytechnic Institute at Yale, Harvard and Leheigh Universities, January 7, 10 and 14.

THE INTERNATIONAL ENGINEERING WORKS, Ltd., announces the purchase of the properties, and complete reorganization of the business formerly owned by the Robb Engineering Co., with increased capital and manufacturing facilities. The boiler works at South Framingham, Mass., will continue to build horizontal return tube, vertical, and Robb-Brady boilers and will complete all manufacturing contracts recently made with the Robb Engineering Co.

MURPHY IRON WORKS announces that Mr. R. M. Bassett, formerly in charge of its Cincinnati office, assumed the management of its Chicago office January 1, 1913, and Mr. James H. McCabe, formerly connected with the engineering department, has assumed the management of the Cincinnati office.

The Cincinnati office, which was badly damaged by the Gibson House fire, has now been repaired and the company is back in its old quarters, 603 Union Trust Building.

ON FEBRUARY 6, 7 and 8, 1913, in the Electrical Laboratory of the University of Illinois, the students of the Department of Electrical Engineering will give their triennial Electrical Show. Although under student management, it will be by no means wholly a student show, as many manufacturing and sales companies in the electrical trade will offer exhibits. Among the exhibits will be isolated lighting plants, heating and cooking accessories, telephone, telegraph, and wireless apparatus, lifting magnets, motor controllers, high frequency machinery, and a complete electrically operated cafe. Student demonstrators or manufacturers' representatives will be in charge of each exhibit. One special feature planned in connection with the show is an exhibit of all types and methods of electrical lighting. This will be in charge of students of electrical illumination who will discuss with interested visitors the best and cheapest ways of lighting their buildings.

Under the general direction of Dr. E. J. Berg, Head of the Department of Electrical Engineering, a business organization composed of graduate and undergraduate students is carrying on the entire work incident to the show.

Sparks From The Advertising Pages

The Consumer Foots the Bill for Advertising But Gets His Money's Worth

The "ultimate consumer" pays for all the costs of production, distribution and sale of commodities—also for all services, of whatsoever kind, that make up the value of an article.

When an article is advertised, its cost is increased by an amount inversely proportioned to the number of sales which the advertising effects.

Who pays for the advertising? The consumer, of course. He pays for everything that enters into the cost of that which he consumes.

Does the consumer get value received for the additional cost which advertising places on commodities? He does, and in four ways.

1. He is *educated,* through advertising with regard to commodities, to discriminate between articles offered for the same purpose and to select that which *best suits his needs and his tastes.*

2. In advertised commodities he receives *best quality,* for experience has proven that it is only goods of the best quality that can be profitably advertised.

3. With advertised commodities he receives what is virtually a *guarantee of quality.* He, also, frequently receives a legal guarantee, and in every case is *protected* by the mere fact that the goods are advertised.

4. He *pays less* for advertised commodities than for those not advertised. Advertising reduces cost of production by increasing output (through expansion of sales) without proportionate increase of cost for labor and equipment. This reduction in cost to the producer can be passed on to the consumer—and *is* passed on for the reason that it is good policy for the producer to reduce the price of his product as much as possible in order to outsell his competitors.

But, it may be said, a manufacturer who does not advertise, can afford to charge less for his product by just as much as he would have spent in advertising.

This sounds well, but the reasoning is fallacious.

When the manufacturer or retailer of an article tells you that it costs you less because he does not advertise, he is fooling himself or is trying to fool you.

Mark this: Every manufacturer, salesman, jobber or retailer, will demand *as high a price as possible* from the consumer. The possible maximum is limited on the one hand by what the purchaser is willing to pay, and, of course, this means that the price must not be higher than that of competitors in the business. On the other hand, an article cannot *continue* to be sold for less than what will repay the cost of manufacturing, etc., and yield a fair profit to all concerned in its production, distribution and sale.

Now, as shown above, the manufacturer who advertises, cuts the total cost of his product even when the additional expense of advertising is allowed for. He can, therefore, *afford* to charge the consumer less. And he *will do so* in order to outsell his rivals. But the non-advertising manufacturer, if he cuts prices in order to make sales, must necessarily *cut his profits,* because the total cost of his product—material, labor, distribution, sales—is greater than that of the advertising manufacturer. Therefore, either his price-cutting or his business must cease, because it will not yield a fair profit.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 30 cents per line. About nine words make a line. No display type allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

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